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1709

U.S. ENVIRONMENTAL PROTECTION AGENCY REGION 9

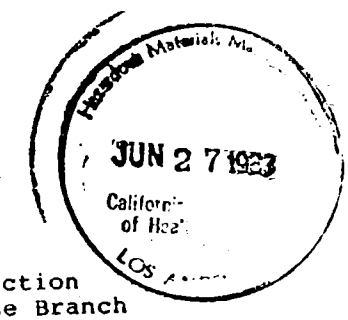
TOXICS AND WASTE MANAGEMENT DIVISION

INVESTIGATION REPORT

Purpose: CERCLA Investigation
Montrose Chemical Corporation
20201 South Normandie Avenue
Torrance, California

Dates of Investigation: November 9-10, 1982

Report Number: C(83)E002



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EPA Region 9

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Environmental Specialist
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Trace Metals Chemist
Southern California Coastal Water
Research Project

Report Prepared by: Steve Simanonok

Final Report Date: April 11, 1983

Background

Montrose Chemical Corporation manufactures, formulates and grinds Dichloro diphenyl trichloroethane (DDT) at 20201 South Normandie Avenue in Torrance, California.[1] The corporation has produced DDT at its present location since May 8, 1947.[2] They are "...the sole manufacturer of DDT in the United States and produces DDT only at its plant at Torrance, California. The estimated production of DDT at this plant for 1975 is about 60 million pounds."[3] A brief history of the pesticide DDT follows:

> "DDT, first synthesized in Germany in 1874, has been used extensively world-wide for public health and agricultural programs. Its efficacy as a broad spectrum insecticide and its low cost make it the insecticide for those measures for most of the world.
>
> Following an extensive review of health and environmental hazards of DDT, U.S. EPA decided to ban its further use. This decision was based on several well evidenced properties such as:
>
> (1) DDT and its metabolites are toxicants with long-term persistence in soil and water,
>
> (2) it is widely dispersed by erosion, runoff and volatilization,
>
> (3) the low-water solubility and high lipophilicity of DDT result in concentrated accumulation of DDT in the fat of wildlife and humans which may be hazardous.
>
> Agricultural use of DDT was cancelled by the U.S. EPA in December, 1972. Prior to this, DDT had been widely used in the U.S. with a peak usage in 1959 of 80 million pounds. This amount decreased steadily to less than 12 million pounds by 1972. Since the 1972 ban, the use of DDT in the U.S. has been effectively discontinued."[4]

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1 Consolidated Permits Program Application to EPA; November 11, 1980; p. 2.

2 Interview with John Kallock, Plant Manager, November 3, 1981.

3 Wastewater Treatment Technology Documentation for DDT Manufacture, EPA Report Number 440/9-76-009, 1976, p.1.

4 Ambient Water Quality Criteria for DDT, EPA Report Number 440/5-80-038, October 1980, p. A-1.

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I. Assessment of Public Health Concerns Associated with Trace Organics in Seafood

J. Changes in the Amount and Proportions of DDT and its Metabolites, DDE and DDD, in the Marine Environment Off Southern California 1949-72

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4 Ambient Water Quality Criteria for DDT, EPA Report Number 440/5-80-038, October 1980, p. A-1.

Since the 1972 EPA ban, the use of DDT in California has declined steadily from 1970 to 1976. After 1976, the use of DDT has not been reported:

USE OF DDT IN CALIFORNIA 1970-1981[5]

Year	Agricultural Applications	Pounds	Agricultural Acres
1970	8,284	1,164,699.91	643,899.13
1971	1,166	111,058.02	63,651.68
1972	913	80,800.27	42,094.90
1973	25	1,295.77	544.40
1974	2	226.56	135.00
1975	0	5.08	0
1976	2	219.64	14.60
1977	0	0	0
1978	0	0	0
1979	0	0	0
1980	0	0	0
1981	0	0	0

While the use of DDT in the United States and California is virtually non-existent, Montrose Chemical Corporation has continued to manufacture DDT for export. Montrose has sold DDT to the World Health Organization, the U.S. Agency for International Development, and directly to foreign nations in the Northern and Southern Hemispheres.[6]

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5 Compiled from Pesticide Use Report, California Dept. of Food and Agriculture, Annual Summaries 1970-1981.

Note: The preface to the Pesticide Use Report states that "for uses of restricted materials requiring a permit (Calif. Administrative Code Section 2450 et. seq.) this report reflects total usage." The Calif. Administrative Code Section 2450(1)(5) lists DDT as a restricted material.

6 Wastewater Treatment, supra, p. 10.

Montrose Chemical Corporation notified EPA of their hazardous waste activity on August 5, 1980. The corporation indicated that they generate and treat/store/dispose of the following wastes:[7]

EPA Hazardous Waste Number	Description
D002	Corrosive
U034	Chloral
U037	Chlorobenzene
U061	DDT

The company's hazardous waste permit application estimates that they produce 50,000 tons/annually of corrosive hazardous waste which is stored in tanks.[8]

EPA conducted a RCRA Interim Status Standards Investigation on December 22, 1980. Company spokesmen stated "that a series of underground collection tanks, each with a 20,000 gallon capacity, are emptied every day by pumping into 50,000 gallon storage tanks. The liquid wastes are hauled away by tank trucks. Montrose has disconnected their sewer line to eliminate all possibility of discharge. All runoff is gathered in an open concrete pit and recycled."[9] (Emphasis added.)

Prior to April 1970, Montrose was discharging its liquid waste directly into a sewer trunk line that led to the Joint Water Pollution Control Plant (JWPCP) of the County Sanitation Districts of Los Angeles County (CSDLAC). The effluent from this plant was subsequently found to contain the highest levels of DDT of any major Southern California municipal wastewater system:

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7 Notification of Hazardous Waste Activity to EPA; August 5, 1980; p. 1-2.

8 Hazardous Waste Permit Application, attached to Consolidated Permits Program Application to EPA; November 11, 1980; p. 3.

9 RCRA Interim Status Standards Investigation, EPA Region 9 Surveillance & Analysis Division Report; February 25, 1981; p. 1.

"Although reliable monitoring of JWPCP effluent did not begin until January 1971, the evidence available indicates that prior to April 1970, Montrose Chemical Corporation was discharging on the order of 300 kg/day total DDT to the CSDLAC sewer system from its pesticide plant located in the City of Torrance. Twenty-four hour composite samples collected from the system above and below Montrose on March 30, 1970 indicated that at this time the plant was discharging approximately 290 kg/day of total DDT to the wastewater system. Although this was the only such sampling conducted before Montrose began hauling its caustic liquor wastes to a landfill disposal site in April 1970, analysis of a sample of this caustic liquor waste taken directly from the Montrose waste stream on August 4, 1970 indicated a total DDT concentration of 3,400 ppm (mg/l). This corresponds to a total DDT emission rate of about 270 kg/day for an average quantity of caustic liquor waste of 83,000 l/day, in good agreement with the earlier estimate (CSDLAC, Jan. 1973). The Montrose plant was built around 1950.

Unfortunately, records of previous Montrose discharges to the wastewater system are not available. However, sewer sediments collected at two stations downstream of Montrose on May 14, 1971 respectively contained 165,000 ppm (16.5 percent) and 130,000 ppm (13 percent) on a dry weight basis, compared to 300 ppm (0.03 percent) found just upstream of Montrose (CSDLAC, May 1971). A subsequent sampling of two stations downstream of Montrose on July 15-16, 1971 revealed sewer sediment total DDT concentrations of 32 percent and 39 percent, respectively, suggesting that almost 30 m[etric] tons of total DDT were contained in the sediments of the 200 m[eter] stretch of pipe between the two stations (CSDLAC, Dec. 1972).

Following the April 1970 initiation of landfill disposal of the Montrose caustic liquor waste, estimates of total DDT discharges by Montrose (based on upstream and downstream collections) decreased significantly, from 290 kg/day on March 30 to 20 kg/day on July 27 (CSDLAC, Dec. 1970). However, direct analysis of Montrose effluent indicated that the reduction in the DDT input rate to the sewer was actually much greater than indicated by the above data. A twenty-four hour composite collected on August 14, 1970 yielded a daily input value of 0.1 kg total DDT, and eight such composites collected between August and December 1970 indicated an average input of 0.2 kg/day (CSDLAC, Jan. 1973).

Despite this very large reduction in DDT discharges to the system, the contamination of sewer sediments downstream from the Montrose connection apparently resulted in a much slower reduction in the emission of total DDT via the JWPCP effluent.

> Five years after the termination of the Montrose input, the MER [Mass Emission Rate] of total DDT to the Palos Verdes shelf (approx. 1 m[etric] ton/yr) was still more than 15 times that from the comparable discharge of Hyperion municipal wastewater into nearby Santa Monica Bay (approx. 0.06 m[etric] ton/year)."[10]

Water researchers have compared five major sewage outfall systems in Southern California. They concluded that "The largest values for both concentrations and horizontal and vertical gradients of DDT compounds are observed in the bottom sediments off Palos Verdes .... There is a 1,000-fold difference between median DDT concentrations in the Palos Verde area and those in the Point Loma areas .... Analysis of DDT concentrations measured in the Palos Verdes sediments indicates that between 180 and 250 metric tons of this pesticide and its residues are contained in the upper 30 cm (12 inches) of a 48 sq km (18.5 sq mi) area around the outfall system."[11]

For a discussion of public health impacts due to the JWPCP discharge, please refer to Appendix I of this report, "Assessment of Public Health Concerns Associated with Trace Organics in Seafood." This assessment concluded that "consumption of fish from the Whites Point area would pose about a 170 times greater risk from DDT than consumption on an equivalent quantity of fish from a control area."[12]

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10 Synoptic Survey of Chlorinated Hydrocarbon Inputs to the Southern California Bight, by David R. Young, Theadore C. Heesen, and Deidre J. McDermott-Ehrlich; Southern California Coastal Water Research Project Authority; June, 1976; pp. 9-12.

11 DDT in Bottom Sediments Around Five Southern California Outfall Systems, Southern California Coastal Water Research Project, December 1974, p. 25.

12 Final Environmental Impact Statement/Environmental Impact Report: Sludge Management Program for the Los Angeles/Orange County Metropolitan Area; EPA Region 9; October, 1980; p. E-28.

DDT has several metabolites, the most frequently found are DDD and DDE.[13] The levels of DDT, DDD, and DDE occurring in marine species found off Southern California have been extensively examined.[14] Levels of DDT, DDD, and DDE in coastal waters have also been studied by the California Mussle Watch Program:

> "The California State Mussel Watch (SMW) Marine Monitoring Program has been operated since 1977 in California under the sponsorship of the State Water Resources Control Board. This monitoring program is performed for the State Board by the California Department of Fish and Game. Monitoring stations have been maintained along the California coastline, in most of the bays and estuaries, and around five of the prominent offshore islands.
>
> The SMW monitors the accumulation of trace metal and synthetic organic toxicants in marine mussels. The monitoring results serve as indicators of spatial and temporal distributions of these toxicants along California's coast. The information is used to identify, or flag, potential problem areas where abnormal accumulations exist. This will lead to isolation of particular pollutant sources in the problem areas for follow-up water quality control actions. In all, eleven trace metals and over fifty synthethic organics are monitored."[15]

The California State Mussel Watch Program Report for 1980-1981 suggested that the higher levels of DDT in the Los Angeles - Long Beach Harbor area was from a recycling of DDT, or a chronic input from surface runoff or aerial fallout.[16] However, it also concluded that the levels of DDT were not the result of recent inputs.[17] This conclusion may have been premature. For 1981,

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13 Ambient Water, supra, p. B-1.

14 Changes in the Amount, and Proportions of DDT and Its Metabolites, DDE and DDD, in the Marine Environment Off Southern California, 1949-72, by John S. MacGregor. Fishery Bulletin: Vol. 72, No. 2, 1974.

15 California State Mussel Watch 1980-81, State Water Resources Control Board, May 1982. Part I, p. 1.

16 California State Mussel Watch, supra, Part III, p. 58.

17 California State Mussel Watch, supra, Part III, p. 62.

the Program expanded the number of mussel watch stations in the Harbor area. Late 1981 data indicated that the greatest concentration of Total DDT and metabolites (DDT + DDD + DDE) was found at the Dominguez Channel location (top of Consolidated Slip).

Since DDT is manufactured as 92% DDT[18], and metabolizes to DDD and DDE, the ratio of DDT to Total DDT and Metabolites can be used to assess the relative age of DDT found in environmental samples.[19] A comparison of these ratios (Appendix C, page 5) indicates that two of the three mussel watch stations with the highest ratios within L. A. Harbor were the nearest to the outlet of Dominguez Channel. Consequently, the Dominguez Channel was not only suspected of having the greatest input of DDT, but also contributing "fresher" DDT than was already in the Harbor.

The mussel data initiated EPA's interest in identifying potential sources of DDT. Montrose Chemical Corporation became a likely suspect, because of its location within seven miles upstream of the Harbor, and its history of DDT production.

A search of state and local agencies' files revealed that the Los Angeles Flood Control District routinely sampled flood control channels for priority pollutant analysis. One of their stations, Torrance Lateral at Main Street, is a tributary of the Dominguez Channel and downstream of Montrose Chemical Corporation. The analysis of water samples at this station shows elevated levels

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18. See page F-1. 77.1% p,p'-DDT + 14.9% o,p'-DDT = 92% DDT

19. See Changes in the Amount, supra.

of DDT, DDD, and DDE, particularly during periods of stormwater flow:

L. A. Flood Control District

Sample Analysis 1977-1982

Mean Concentrations (Parts per Billion)

	DDT	(%)	DDD	(%)	DDE	(%)	Total DDT and metabolites (100%)
dry weather	.30	(40)	.11	(15)	.34	(45)	.75
wet weather	4.90	(83)	.38	(6)	.60	(10)	5.88

This analysis also indicates that "fresher" DDT is released in stormwater flows than during periods of dry weather. Their station location and sample results, since 1977, are included as Appendix A to this report. Also include are STORET summaries of sample results, and statistical summaries of wet and dry weather flows.

Investigation

The purpose of the investigation was to determine whether DDT is being released in stormwater from the Montrose facility, entering a storm drain, and flood control channel. Soil sampling was planned to determine whether property adjacent to the Montrose facility has been contaminated with DDT. All sampling was performed off-site from Montrose Chemical Corporation property. If significant concentrations of DDT are found in stormwater leaving the site, then stormwater on-site is expected to be contaminated. Likewise, if soils are contaminated off-site, significant amounts of DDT would be expected to exist on-site. Since no on-site sampling was to be performed, no notice of this investigation was given to Montrose Chemical Corporation.

Prior to sampling, permission to sample was obtained from Farmers Bros. Coffee, Los Angeles Dept. of Water and Power, and the Los Angeles Flood Control District. The L. A. Flood Control District installed an EPA lock on a gate to the flood control channel access road at the southwest corner of Torrance Blvd. and Vermont Ave. EPA access was necessary to obtain a stormwater sample at the point where an underground storm drain (Project 685) discharges into an open box channel.

On November 9, 1982, Emily Pimentell and Steve Simanonok arrived at Farmers Bros. Coffee. While it was not raining, it had rained during the night. Water was still flowing through the holes in the curb of the Farmers Bros. parking lot and into the catch basin in the parking lot. The investigators obtained a sample of this water using a hexane-rinsed, galvinized steel trough to collect the water as it ran across the pavement, prior to entering the catch basin. We were joined soon afterwards by Pat Herschelman and Rich Gossett, who had agreed to assist us with the water sampling for the day. We then proceeded to sample the water in the ditch leaving the Montrose facility.

This being the first time I had been to the site during wet weather conditions, the flow path was now apparent between the Montrose facility and Farmers Bros. Coffee. The ditch is about two feet wide and four to six inches deep. Water leaves the south-east corner of the Montrose facility in a ditch which passes under a chain link fence and flows south to Farmers Bros. Coffee on the west side of the Southern Pacific Railroad tracks. The stormwater runs 500-600 feet from where it leaves the Montrose facility, and

ponds between the railroad tracks and a parking lot curb at Farmers Bros. Coffee. When the pond reaches a height of several inches, it overflows through holes in the curb, flows across the pavement and into the catch basin where we had sampled earlier. The flow patn to L.A. Harbor and San Pedro Bay is included as pages 26-32 to this report.

Since the rain had stopped prior to our arrival that morning, we decided to postpone further water sampling until it began raining again, since we wanted to obtain water samples during actual rain conditions. At 11:31 am it began to rain, and we resampled at the same locations as earlier that morning. This time we obtained duplicate samples of the water flowing into the catch basin at Farmers Bros. Coffee. Emily hexane-rinsed the trough and then rinsed it with the water to be sampled, prior to obtaining the duplicate samples at the Farmers Bros. location.

Pat Herschelman and Steve Simanonok then proceeded to the flood control channel where the underground storm drain (Project 685) discharges into an open concrete channel. We sampled this discharge using a depth-integrating sampler, an apparatus which holds one sample bottle and is lowered by rope into the water. A fin on the sampler points the bottle opening into the flow to be sampled. By raising and lowering the rope during sampling, a representative sample of the water flow is obtained.

Meanwhile, Emily Pimentell and Richard Gossett went to a catch basin at the corner of Knox and Pacific Gateway Drive to obtain a stormwater sample that was not downgradient of the Montrose facility.

We assumed that this sample would contain background amounts of DDT from other sources, such as aerial fallout of DDT from Montrose grinding operations (see Appendix D for a discussion of the aerial fallout of DDT).

We then proceeded to our final water sample location, Torrance Lateral at Main Street, where the open box channel has been sampled since 1977 by the Los Angeles Flood Control District (see Appendix A). We again used the depth-integrating sampler. Unfortunately, this sample was broken during shipment to the laboratory for analysis. However, the L.A. Flood Control District did obtain a sample at this location the following day.

After obtaining the Torrance Lateral at Main Street sample, we returned to our previous location off-site from the Montrose facility to take a blank sample. This entails transferring an uncontaminated sample of water (sold as steam iron water) to an EPA sample bottle in the area of the greatest suspected contamination. This blank sample is then labeled, numbered and shipped to the laboratory in the identical manner, and along with, the other water samples. This procedure checks against contamination during sampling and cross-contamination during shipping. Furthermore, it is a check of laboratory quality control, since the identity of the blank sample is unknown to the laboratory.

Because I expected the area at the southeast corner of the Montrose facility to have the greatest contamination, I went to this location (as twice earlier that day) to transfer the blank sample. While

standing near the Montrose fence, a Montrose employee wearing a hardhat labeled "Jody" appeared and demanded to know who I was and what I was doing there. I told him that I was an EPA investigator and was obtaining water samples. He went into a building on-site and returned with his own sample bottle. He sampled the stream flow on the Montrose side of the fence. Montrose records should indicate a water sample which corresponds by date and time to the EPA blank water sample.

On the following day, November 10, 1982; Emily Pimentell and Steve Simanonok returned to the site to obtain soil samples. We were joined by John Wakamatsu of the Los Angeles Dept. of Water and Power, who had requested duplicate soil samples from their property. I presented John my EPA credential and explained the activities that were to follow. We had established a grid pattern on the ground the previous day and marked the intersecting corners of each 75x75 foot square area (5625 sq. ft.) with an orange flag. These flags were to be used as reference points to describe sample locations. We obtained a total of 10 soil samples. Duplicate samples and a combination Receipt for Samples and Chain of Custody was issued to John Wakamatsu.

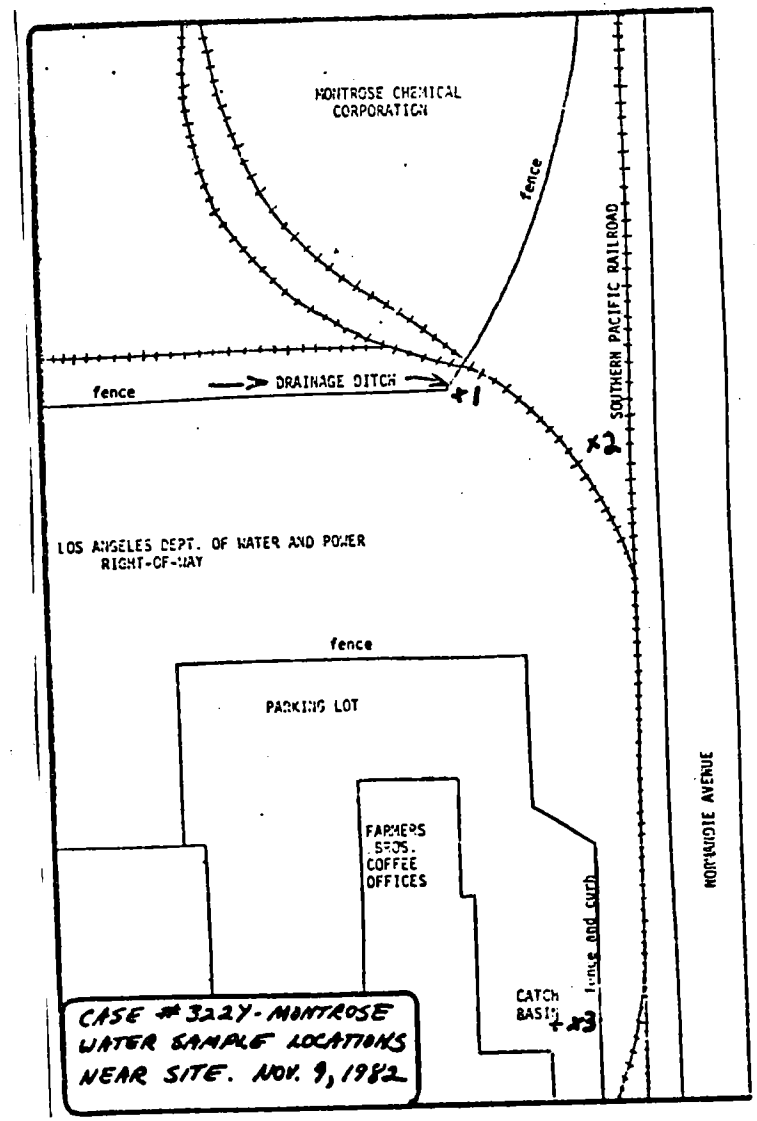
Water and soil sample analysis summaries are presented on pages 14-16 of this report. More detailed summaries are included on pages 57-59 of this report.

Sampling locations and methodology are further described by EPA's Technical Assistance Team in Appendix E of this report.

WATER SAMPLES NEAR SITE

PARTS PER BILLION

Location	Total DDT
1	209
1	360
1 (blank)	<0.1
2	695
3	483
3	244
3	187



WATER SAMPLES DOWNSTREAM

PARTS PER BILLION

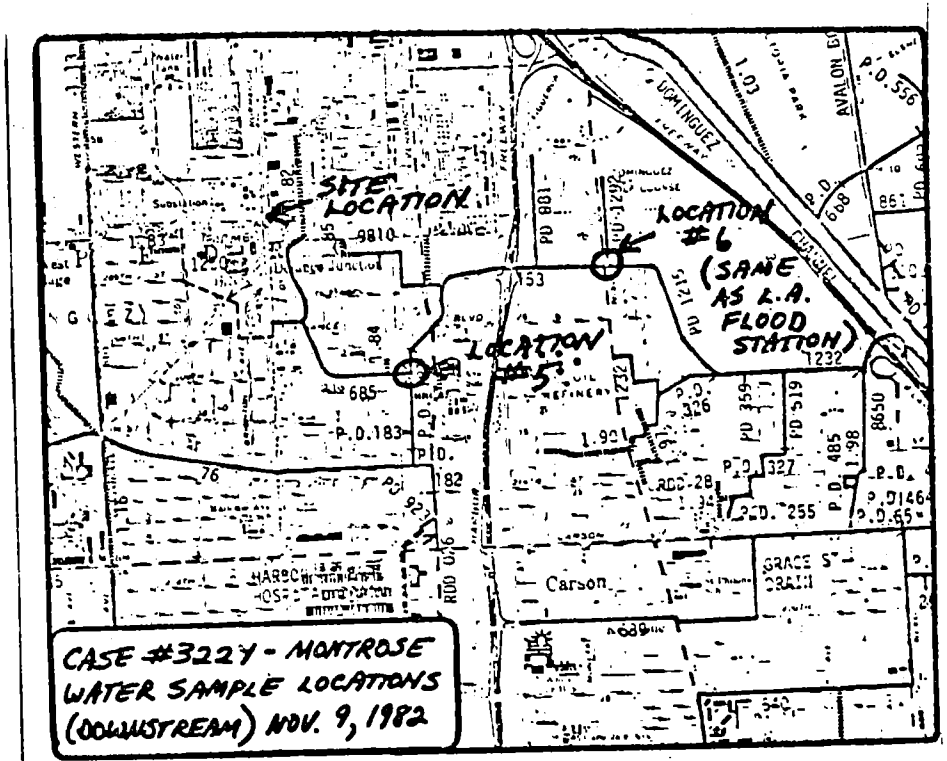
Location	Total DDT
5	17.29

L. A. FLOOD CONTROL DISTRICT

SAMPLE ANALYSIS

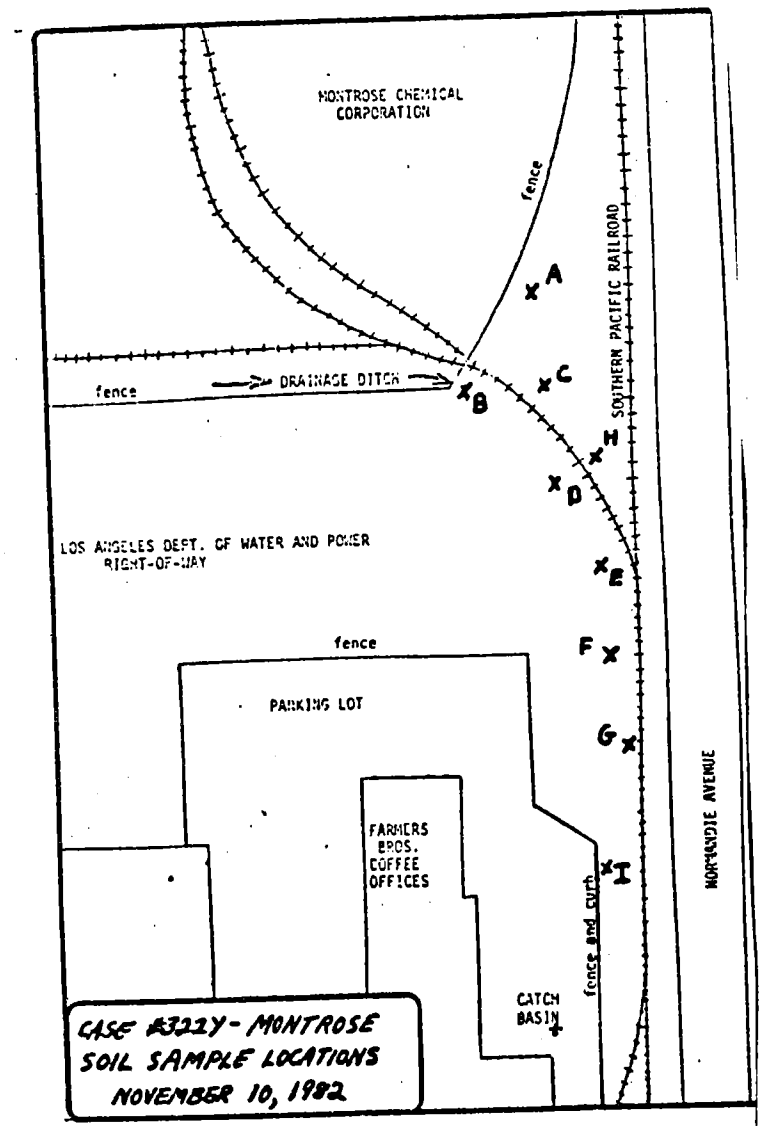
1977 - 1982

Location	Total DDT
6 (dry weather)	.75
6 (wet weather)	5.88



SOIL SAMPLES - PARTS PER MILLION

Location	Total DDT
A	1,915
B	1,975
C	24
D	229
E	1,246
F	143
G	252
H	178
H	375
I	499



CONCLUSIONS

1. DDT and its metabolites, DDD and DDE, are leaving the Montrose Chemical Corporation site via stormwater runoff. This discharge enters a catchbasin at Farmers Bros. Coffee approximately 500 feet south of Montrose. The underground storm drain system runs for approximately 3/4 mile, where it discharges into the Torrance Lateral Flood Control Channel. This channel then runs for about 2 miles to the Dominguez Channel, a tributary of Los Angeles Harbor and San Pedro Bay. The total distance between the site and L.A. Harbor is about 9 1/4 miles (as the water flows).

2. EPA water sample analyses "significantly underestimate the DDT and related compounds of a stream" (p. 56). Despite the underestimation, the DDT concentrations found leaving the site and entering the catchbasin range from 209 to 483 parts per billion.

3. The discharge of DDT and its metabolites has contaminated soils off-site to levels as high as 1900 parts per million (.19%). These soils are readily accessible to the public, with residential areas located within 500 feet. Human contact with contaminated soils and water is a potential threat.

4. The off-site soil and water contamination is adjacent to Farmers Bros Coffee plant. Air and water pathways into the plant were not a subject of this investigation.

5. Los Angeles Flood Control District water monitoring data indicate that DDT/D/E releases have been occurring since monitoring began in 1977. Statistical summaries of this data indicate that the DDT concentration in stormwater flows is at least five times the DDT concentration found in dry weather discharges.

6. The stormwater runoff remains unabated and represents a significant input of DDT and metabolites to the marine environment. California State Mussel Watch data indicate elevated levels of DDT and metabolites entering L. A. Harbor from Dominguez Channel. Toxics monitoring of fish tissue from the L. A. Harbor area shows consistently high levels of DDT.

7. Montrose sewer discharges (which have now been controlled) have created a large "reservoir" of the pesticide in off-shore sediment.

8. According to recent EPA estimates (Appendix I), consumption of seafood from the Whites Point area may present an elevated health risk due to DDT contamination. The risk is presumably greater for those individuals who consume large portions of fish in their diet.

PHOTOGRAPHS

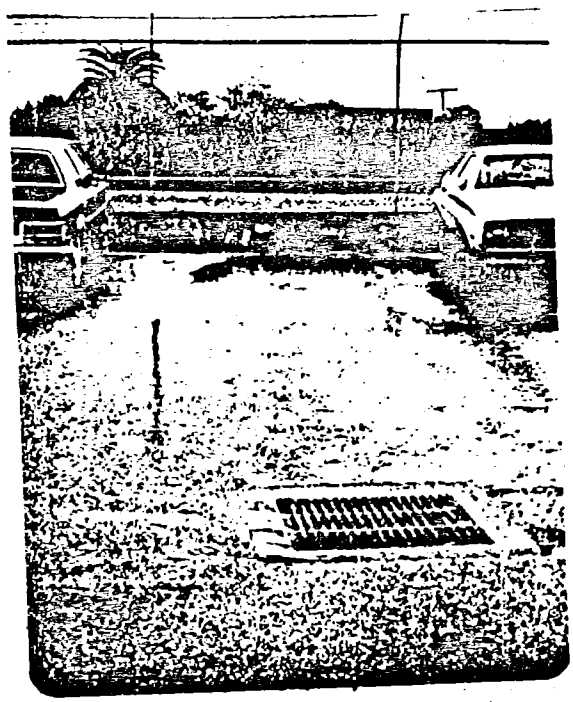
Photographer: Steve Simanonok

Camera: Nikkon EM
50mm lens (unless specified)

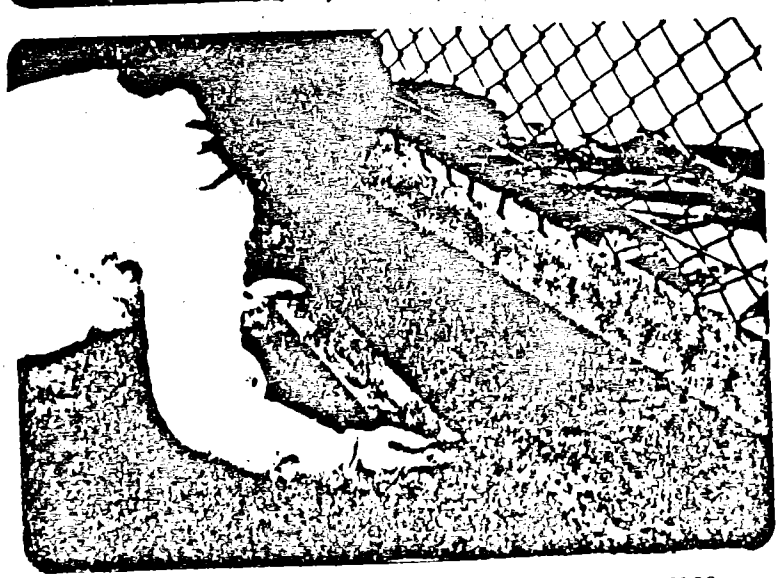
Exposure: Automatic

Film: Kodak Ektachrome
ASA 200

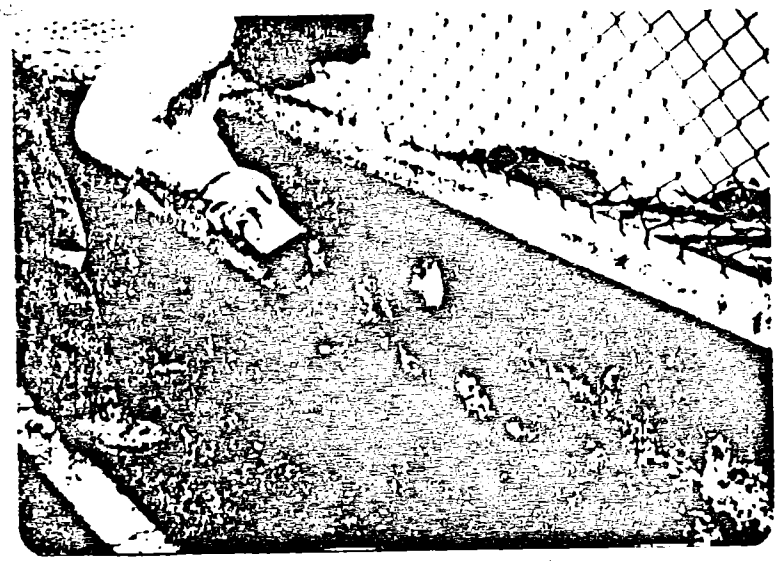
Date: November 9, 1982 (unless specified)



7:50 am - Discharge flowing through curb into catch basin at Farmer's Bros. Coffee parking lot.

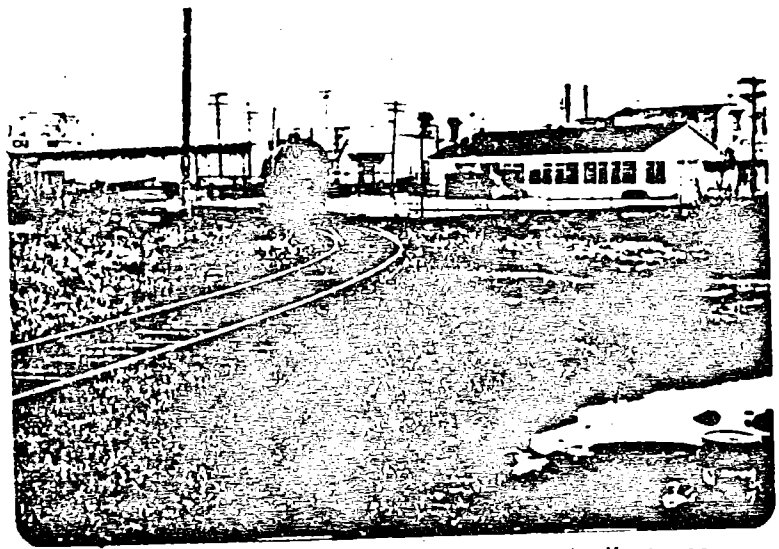


Emily pre-rinsing trough prior to taking sample Y2122.



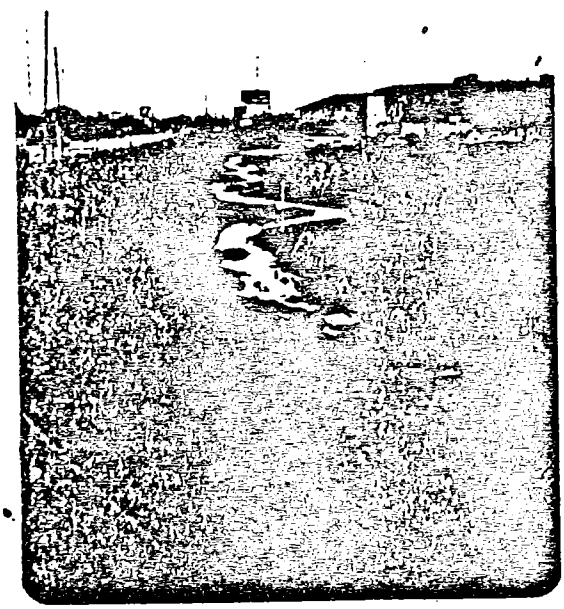
7:55 am - Emily obtaining sample Y2122 at Farmer's Bros. Coffee parking lot

9:28 am - Emily obtaining sample Y2123 from ditch leaving Montrose.

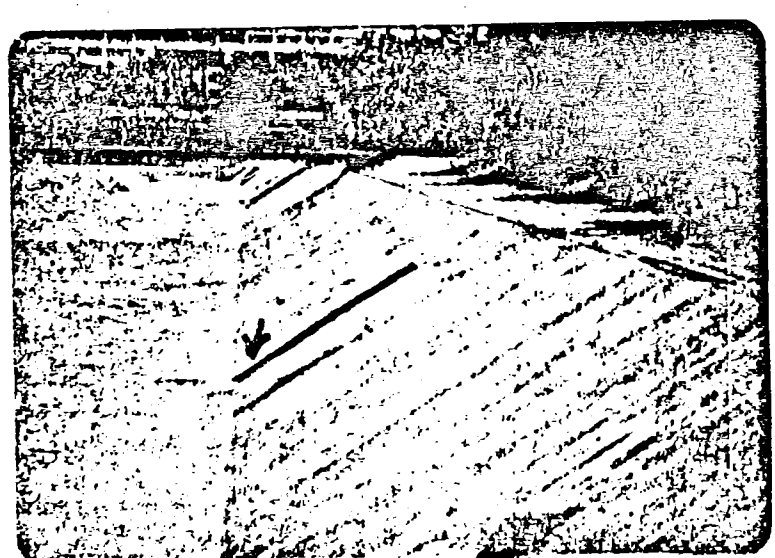


View from railroad tracks to northwest onto Montrose property (behind fence). Emily standing where she obtained sample Y2123.

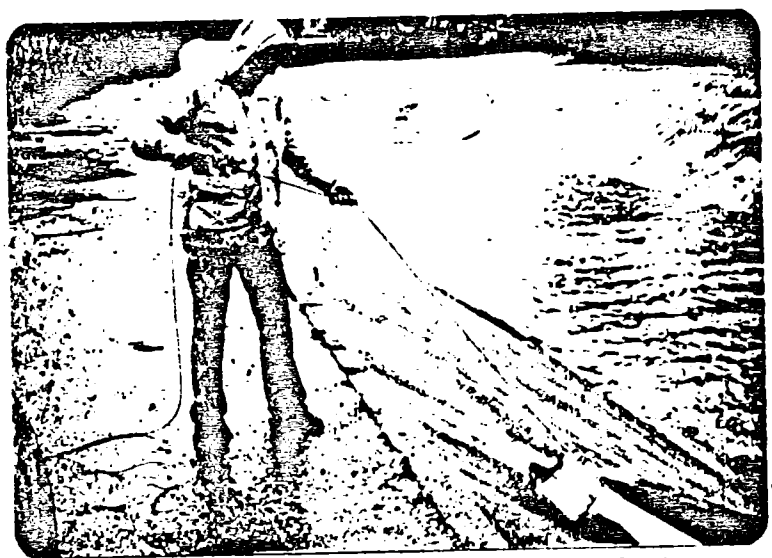
View from sampling point (above) leaving Montrose property.



View to south along railroad tracks. Discharge flowing from Montrose ditch to Farmer's Bros. Coffee (at right).

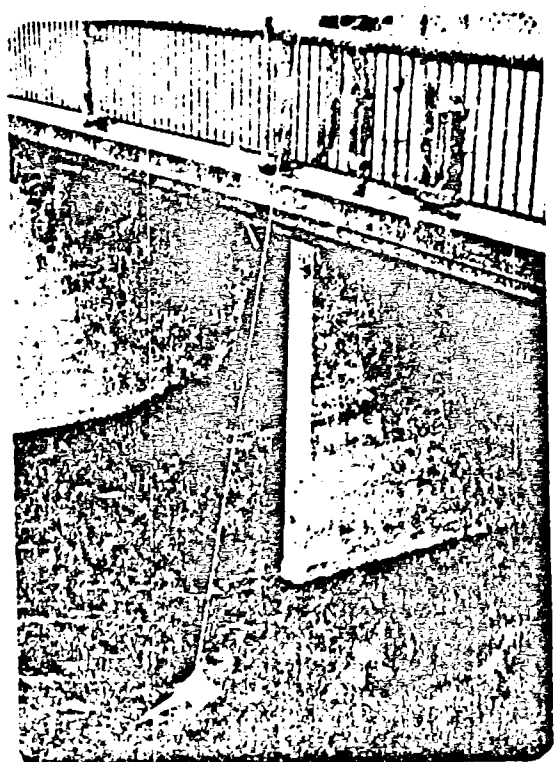


200 mm telephoto of Flood Control Channel. Arrow points to outlet point of Project 685 (see next two photos).

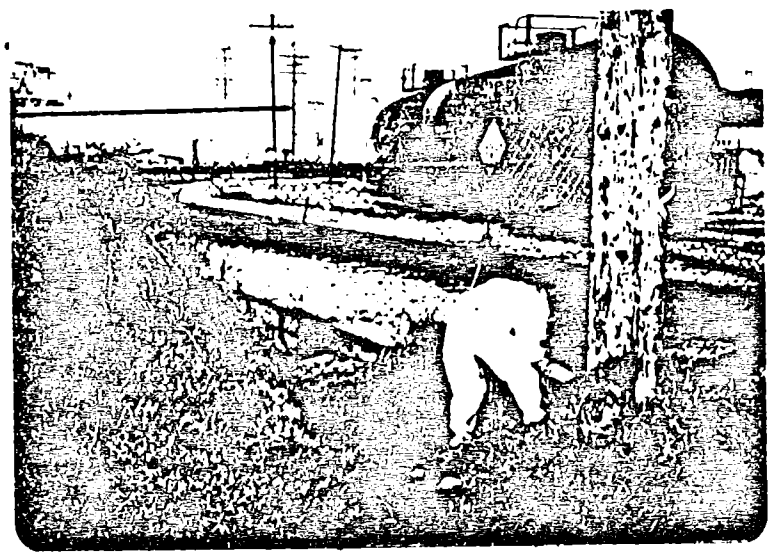


Pat Herschelman obtaining sample Y2128 where Flood Control Project 685 "daylights" into open channel.

View down into Flood Control channel. Depth-integrating sampler faces into outlet of Project 685.

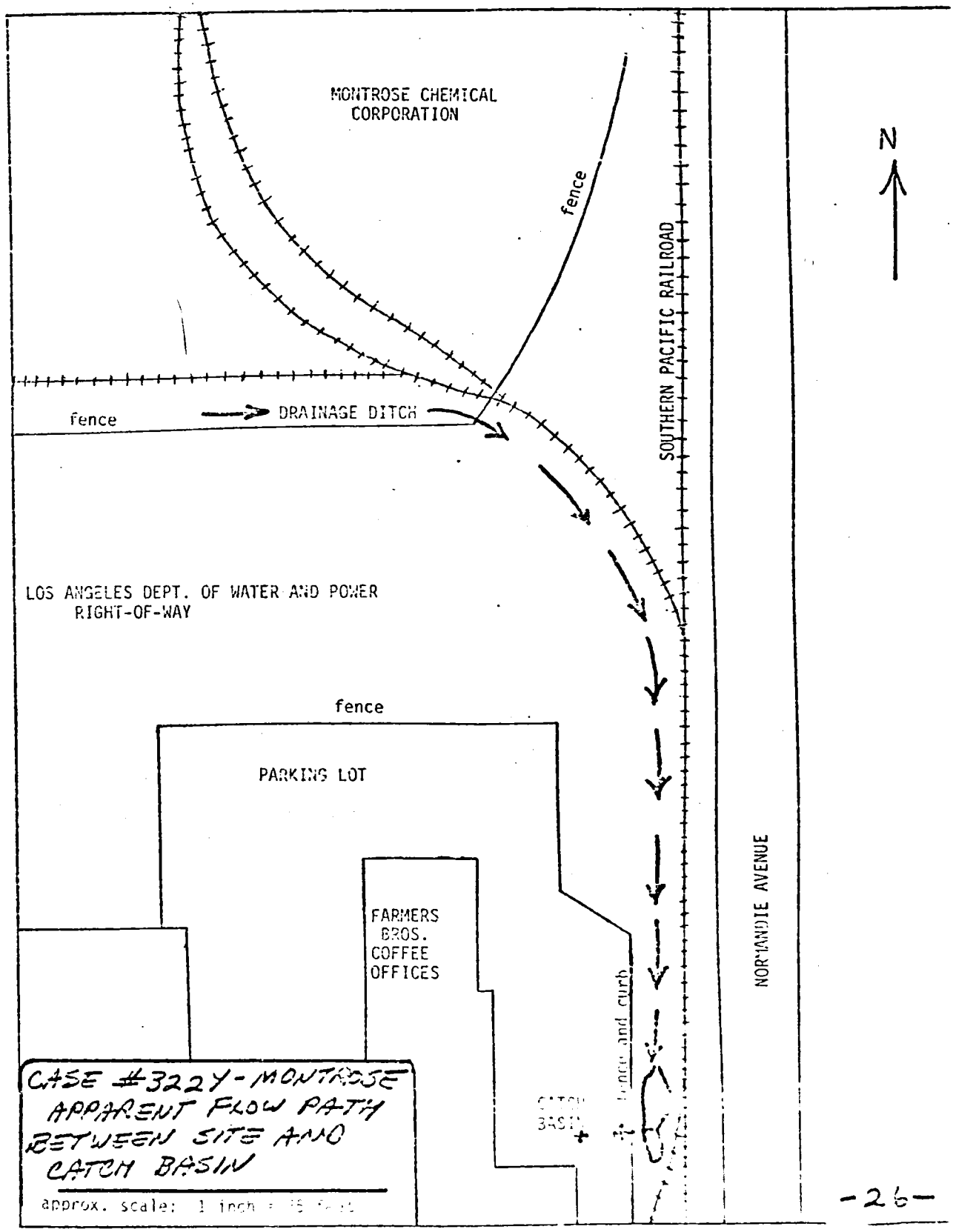


Sample 12129 from Torrance Lateral at Main Street. Depth-integrating sampler faces into direction of flow.

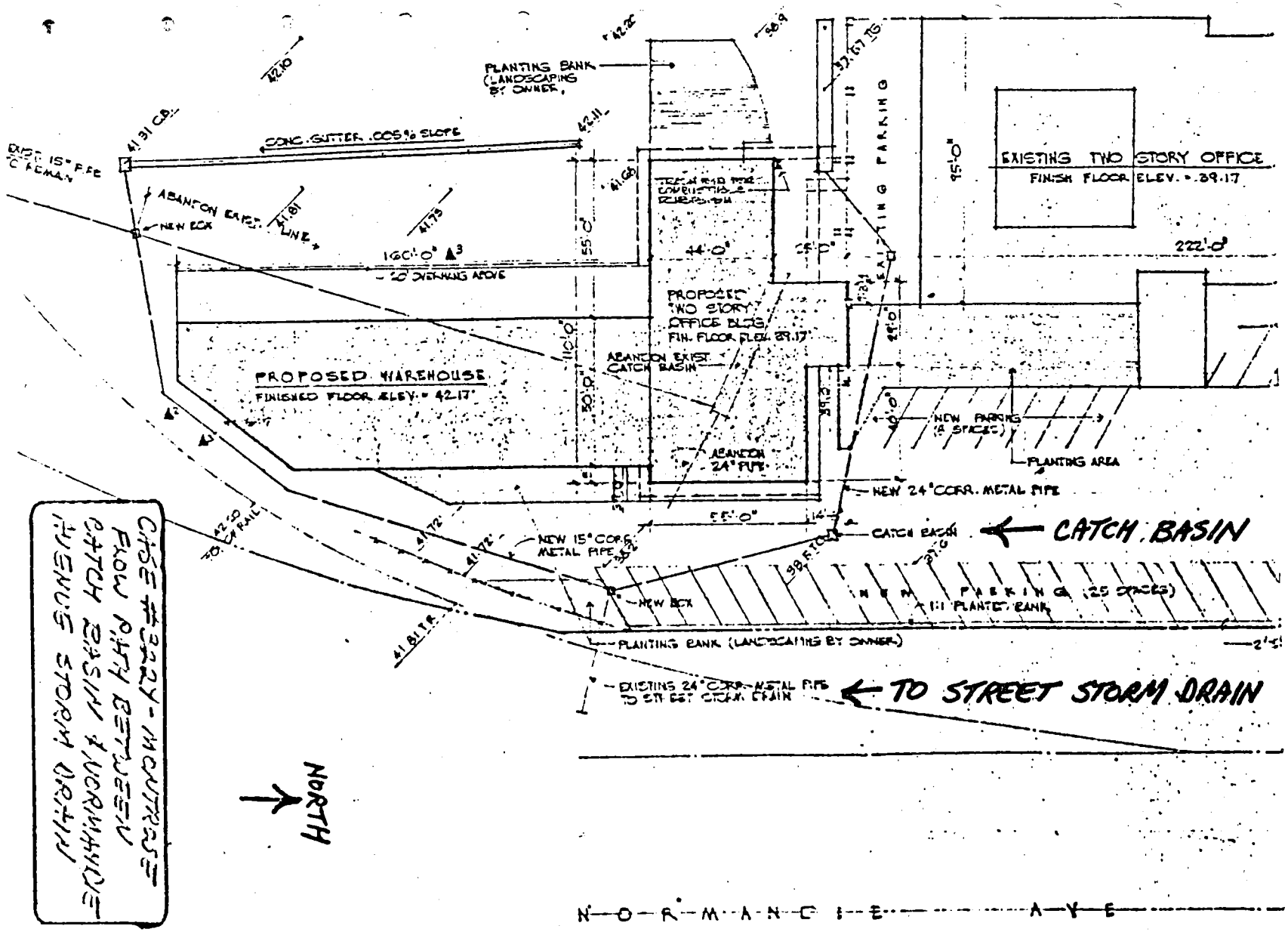


11/10/82 10:45am. Emily obtaining soil sample #2133 from Location B - Outside Montrose fence adjacent to drainage ditch.

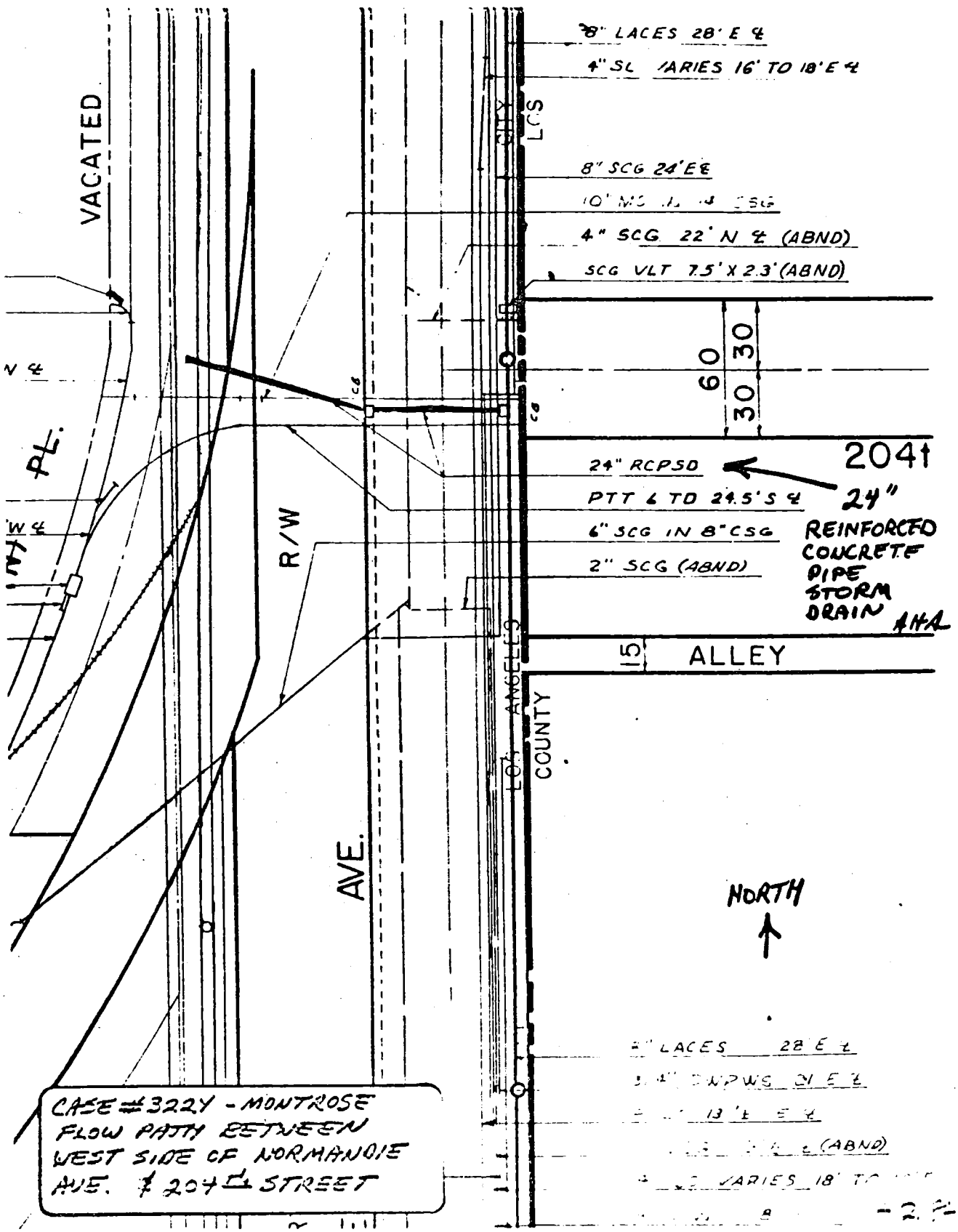
11/10/82 11:10am. Emily obtaining soil sample #2135 from Location D - Adjacent to drainage ditch.

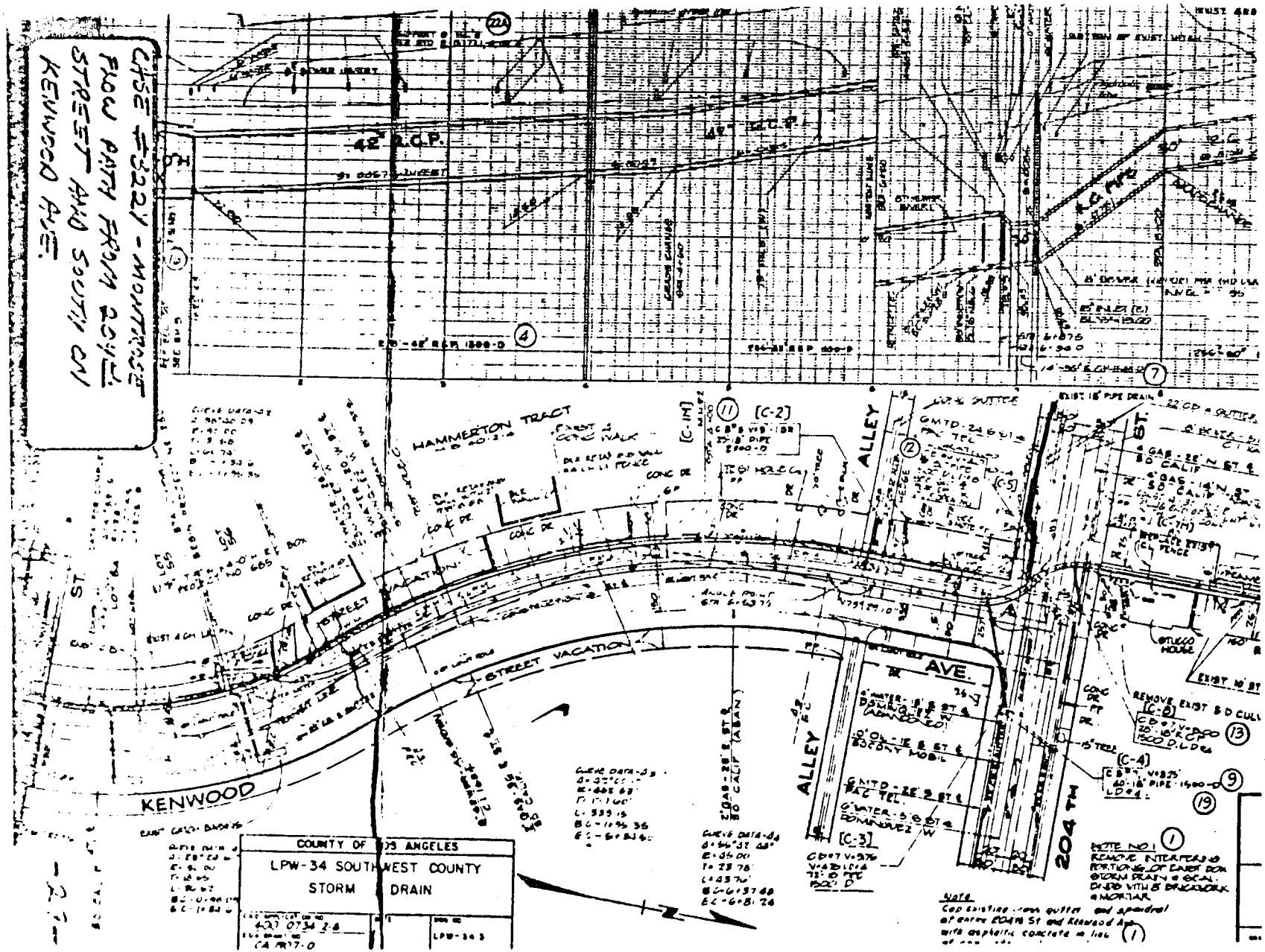


-26-

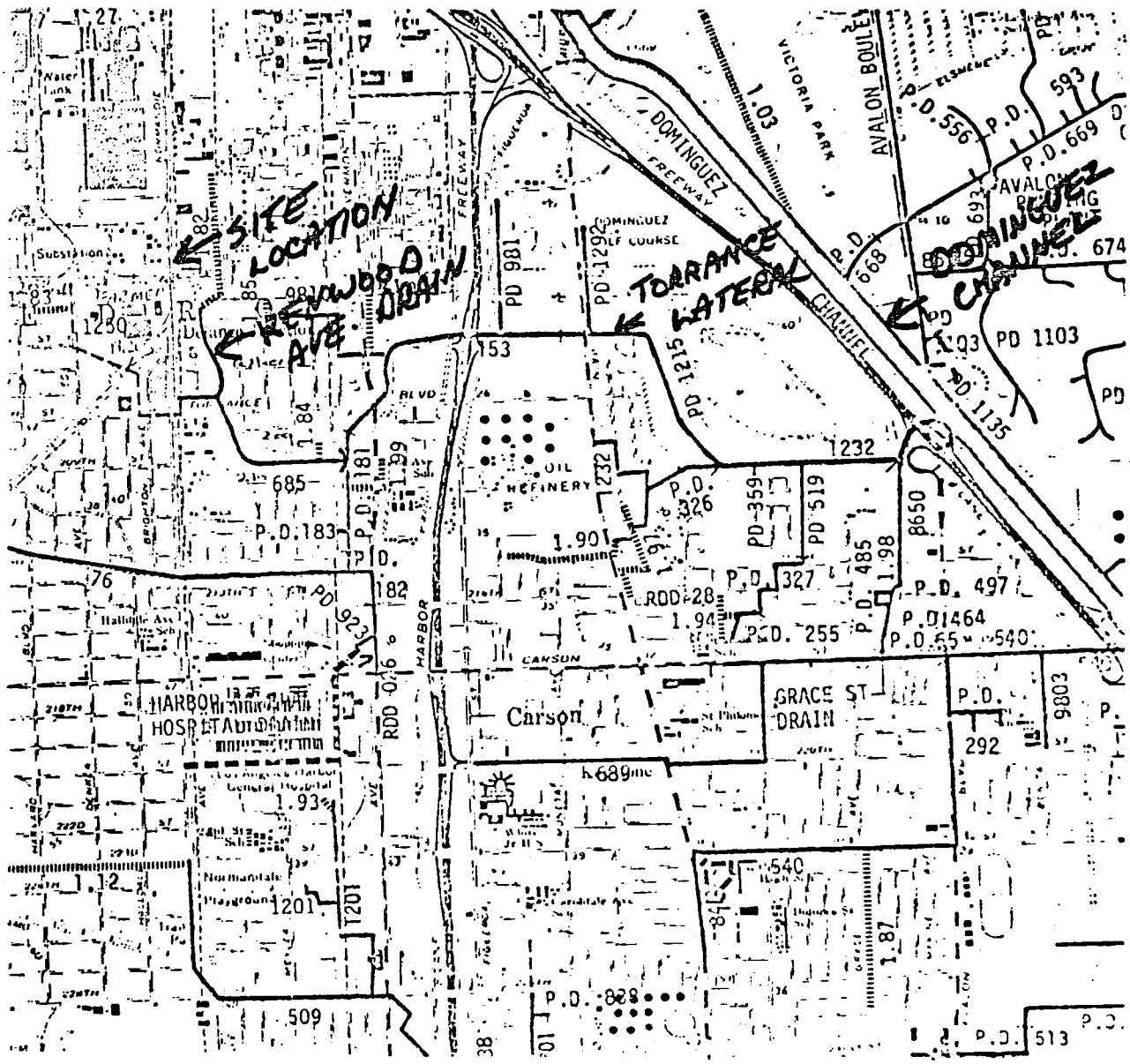


PARTIAL PLOT PLAN

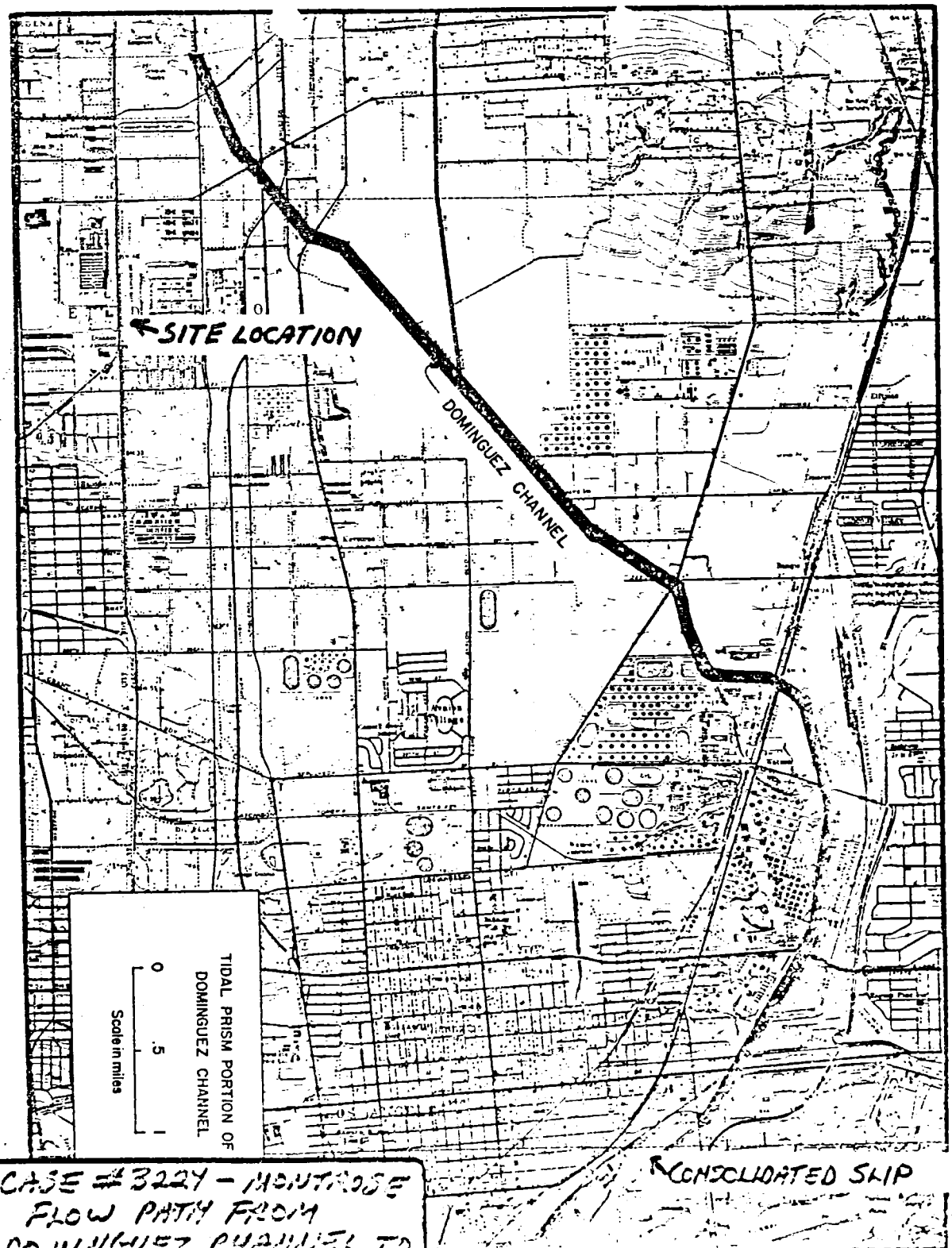




0771



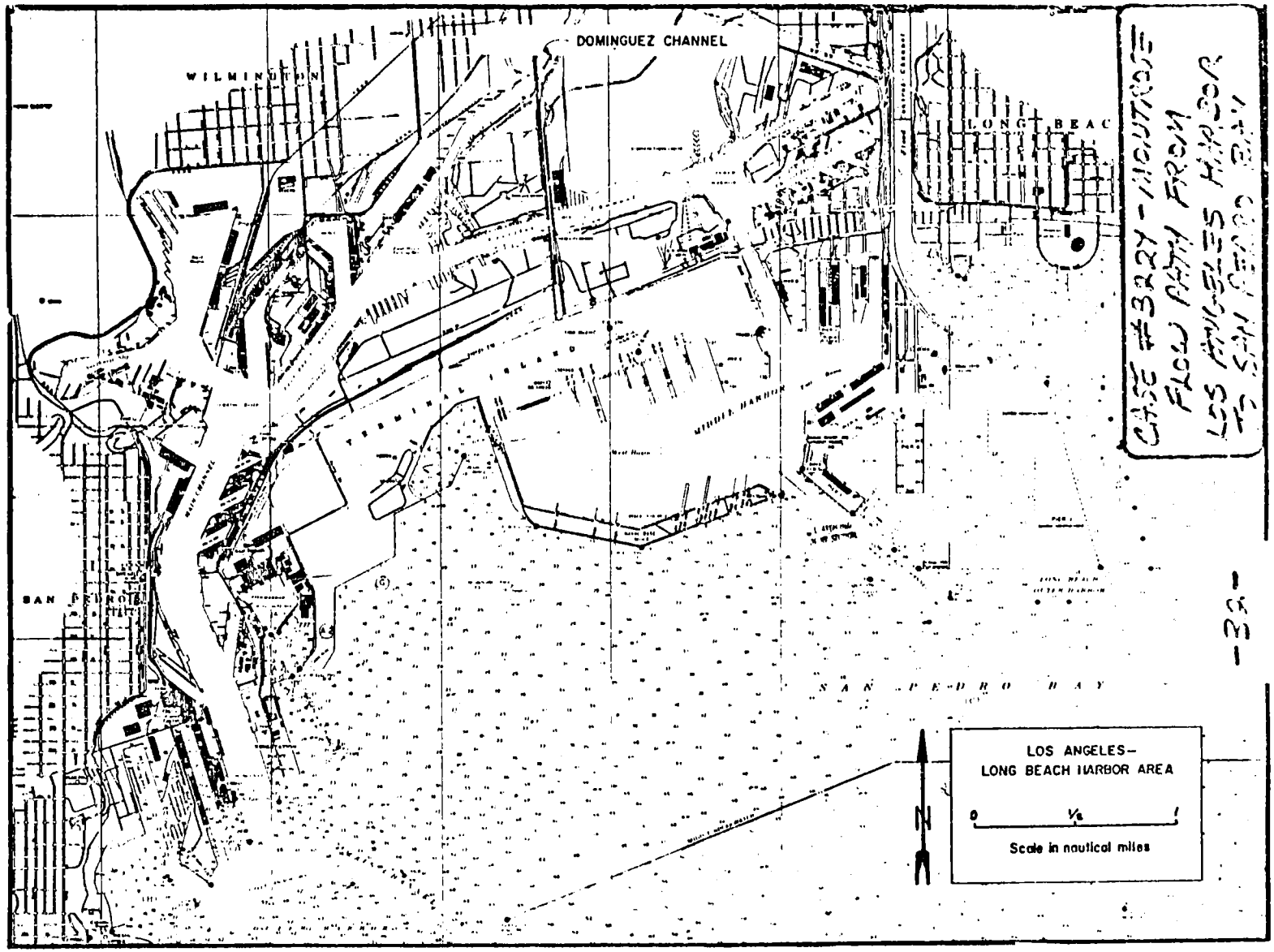
CASE #3224 - MONTROSE
FLOW PATH FROM
KENWOOD AVENUE TO
DOMINGUEZ CHANNEL



CASE #3224 - MONTHLY FLOW PATH FROM DOMINGUEZ CHANNEL TO LOS ANGELES HARBOR

-21-

1743



CASE #3327 - EXHIBIT
FLOW PATH FROM
LOS ANGELES HARBOR
TO SAN GABRIEL RIVER

-23-

ENVIRONMENTAL PROTECTION AGENCY
Office of Enforcement

REGION 9
215 Fremont Street
San Francisco, California 94105

CHAIN OF CUSTODY RECORD

PROJ NO: -17 2-Y
PROJECT NAME: MONTROSE CHEMICAL CO.
SAMPLERS (Signature): Sterling Hardcastle, Jeff Gilman, Richard Bassett, Emily Silveira

STA NO	DATE	TIME	COMP	GRAB	STATION LOCATION	NO. OF CONTAINERS	REMARKS
	11/7/82			/	Sample No. Y 9-2122	1	surface water samples (½ gallons)
	11/8/82			/	9-2123		
	11/8/82			/	9-2124		
	11/8/82			/	9-2125		
	11/8/82			/	9-2126		
	11/8/82			/	9-2127		
	11/8/82			/	9-2128		
	11/8/82			/	9-2129		
	11/8/82			/	9-2130		
	11/8/82			/	9-2131		

Relinquished by (Signature)	Date / Time	Received by (Signature)	Relinquished by: (Signature)	Date / Time	Received by: (Signature)
Sterling Hardcastle, Richard Bassett	11-9-82 14:45	Emily Silveira			
Relinquished by (Signature)	Date / Time	Received by: (Signature)	Relinquished by: (Signature)	Date / Time	Received by: (Signature)
Emily Silveira	11-9-82 16:20				
Relinquished by (Signature)	Date / Time	Received for Laboratory by: (Signature)	Date / Time	Remarks	
	11-9-82 16:20				

Distribution: Original Accompanies Shipment; Copy to Coordinator Field Files

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FEDERAL EXPRESS

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AIRBILL NUMBER 105668533

YOUR FEDERAL EXPRESS ACCOUNT NUMBER 0961-8264-8

DATE 11/7/92

FROM (Your Name)

COMPANY

DEPARTMENT/FLOOR NO

STREET ADDRESS 19 FREMONT ST

CITY SAN FRANCISCO STATE CA ZIP 94105

TO (Recipient's Name)

COMPANY

DEPARTMENT/FLOOR NO

STREET ADDRESS (P.O. BOX NUMBERS ARE NOT DELIVERABLE)

CITY STATE ZIP

AIRBILL NO. 105668533

BY TENDERING THIS SHIPMENT, SHIPPER AGREES THAT F.E.C. SHALL NOT BE LIABLE FOR SPECIAL, INCIDENTAL OR CONSEQUENTIAL DAMAGES ARISING FROM CARRIAGE HEREOF. F.E.C. DISCLAIMS ALL WARRANTIES, EXPRESS OR IMPLIED, WITH RESPECT TO THIS SHIPMENT. THIS IS A NON NEGOTIABLE AIRBILL SUBJECT TO CONDITIONS OF CONTRACT SET FORTH ON REVERSE OF SHIPPER'S COPY. UNLESS YOU DECLARE A HIGHER VALUE, THE LIABILITY OF FEDERAL EXPRESS CORPORATION IS LIMITED TO $100.00

YOUR NOTE/REFERENCE NUMBER (FIRST 12 CHARACTERS WILL ALSO APPEAR ON INVOICE)

PAYMENT ☐ 3rd Country ☐ Bill Recipient's F.E.C. Acct. ☒ Bill 3rd Party F.E.C. Acct. ☐ Bill Credit Card/
☐ Cash In Advance Account Number/Credit Card Number 1441-4

SERVICES (CHECK ONLY ONE BOX)
PRIORITY ONE (P-1) OVERNIGHT LETTER
COURIER PAK
STANDARD AIR
"OVERNIGHT" IS DEFINED AS NEXT BUSINESS DAY (MONDAY THROUGH FRIDAY). SEE SPECIAL HANDLING FOR SATURDAY DELIVERY.

DELIVERY AND SPECIAL HANDLING (CHECK SERVICES REQUIRED)
1 ☐ HOLD FOR PICK UP AT FOLLOWING FEDERAL EXPRESS LOCATION SHOWN IN SERVICE GUIDE
2 ☒
3 ☐
4 ☐
5 ☐
6 ☐
7 ☐
8 ☐
9 ☐

PIECES	WEIGHT	DECLARED VALUE	O/S
1			
1			
TOTAL	TOTAL	TOTAL	

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☐ ON CALL STOP
☐ F.E.C. LOC

Federal Express Corporation Employee No.

DATE/TIME For Federal Express Use

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FREIGHT CHARGES
DECLARED VALUE CHARGE
AGT/PRO
AGT/PRO
ADVANCE ORIGIN
ADVANCE DESTINATION
OTHER
TOTAL CHARGES

PART # 2041738000
REVISION DATE 3/91 GBF
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BOE-C6-0176718

1 7 5

U.S. ENVIRONMENTAL PROTECTION AGENCY — EMSL Sample Management Office

ORGANICS TRAFFIC REPORT

Sample Number Y 2122

① **Case Number:** SAS 322Y

Sample Site Name/Code: Montrose Chem, Torrance CA

② **SAMPLE CONCENTRATION** (Check One)

X **Low Concentration**
__ **Medium Concentration**

③ **SAMPLE MATRIX** (Check One)

X **Water**
__ **Soil/Sediment**

④ **Ship To:** California Analytical Lab, Inc 5895 Power Inn Rd Sacramento, Ca 9-

Attn: Bonnie Meikel

Transfer Ship To:

⑤ **Regional Office:** 9

Sampling Personnel:

Steve Simanek (Name)

(415) 974-7406 (Phone)

Sampling Date: 11-9-82 (Begin) (End)

⑥ **For each sample collected specify number of containers used and mark volume level on each bottle.**

	Number of Containers	Approximate Total Volume
Water (Extractable)	1	1/2 gal
Water (VOA)		
Soil/Sediment		
Water (Ext/VOA)		
Other		

⑦ **Shipping Information**

Federal Express
Name of Carrier

11-9-82
Date Shipped:

[illegible]
Airbill Number:

⑧ **Sample Description**

X Surface Water __ Mixed Media
__ Ground Water __ Solids
__ Leachate __ Other (specify) _____

⑨ **Sample Location**

⑩ **Special Handling Instructions:**
(e.g., safety precautions, hazardous nature)

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1-3-7-

U.S. ENVIRONMENTAL PROTECTION AGENCY — Hazardous Waste Management Division

ORGANICS TRAFFIC REPORT

Sample Number: Y 2123

1774

① Case Number: SAS 2224

Sample Site Name/Code: Montrose Chem Torrance, Ca

② SAMPLE CONCENTRATION (Check One)

X Low Concentration
___ Medium Concentration

③ SAMPLE MATRIX (Check One)

X Water
___ Soil/Sediment

④ Ship To:

Contr. Analytical Lab Inc
5895 Power Inn
Sacramento, Ca 95824
Attn: Bonnie Metcal

Transfer
Ship To:

⑤ Regional Office: 9

Sampling Personnel:

Steve Simanonak
(Name)
415 974 1406
(Phone)

Sampling Date: 11-1-87
(Begin) (End)

⑥ For each sample collected specify number of containers used and mark volume level on each bottle.

	Number of Containers	Approximate Total Volume
Water (Extractable)	1	1/2 gal
Water (VOA)		
Soil/Sediment		
Water (Ext/VOA)		
Other		

⑦ Shipping Information

Federal Express
Name of Carrier

11-1-87
Date Shipped:

1 [illegible] 22
Airbill Number:

⑧ Sample Description

X Surface Water ___ Mixed Media
___ Ground Water ___ Solids
___ Leachate ___ Other (specify) _____

⑨ Sample Location

⑩ Special Handling Instructions:
(e.g., safety precautions, hazardous nature)

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-34-

BOE-C6-0176720

U.S. ENVIRONMENTAL PROTECTION AGENCY HW Sample Management Office
P.O. Box 818

ORGANICS TRAFFIC REPORT

Sample Number Y 2124

1 Case Number: AS 322Y

Sample Site Name/Code: Montrose chem Terrace, Co.

2 SAMPLE CONCENTRATION (Check One)
X Low Concentration
___ Medium Concentration

3 SAMPLE MATRIX (Check One)
X Water
___ Soil/Sediment

4 Ship To: Gilt Analytical Lab Inc 5895 Power Inn Rd Sacramento, Ca. 95824 Attn: Bonnie Winzler

Transfer Ship To:

5 Regional Office: 9

Sampling Personnel: Steve Simanonk (Name)

415 974-7406 (Phone)

Sampling Date: 11-9-82 (Begin) (End)

6 For each sample collected specify number of containers used and mark volume level on each bottle.

	Number of Containers	Approximate Total Volume
Water (Extractable)	1	1/2 gal
Water (VOA)		
Soil/Sediment		
Water (Ext/VOA)		
Other		

7 Shipping Information

Federal Express Name of Carrier

11-9-82 Date Shipped:

1056405522 Airbill Number:

8 Sample Description

X Surface Water ___ Mixed Media
___ Ground Water ___ Solids
___ Leachate ___ Other (specify) _____

9 Sample Location

10 Special Handling Instructions:
(e.g., safety precautions, hazardous nature)

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(-37-)

1-1762

BOE-C6-0176721

U.S. ENVIRONMENTAL PROTECTION AGENCY - EMSL Sample Management Office
P.O. Box 818, Alexandria, VA 22313

ORGANICS TRAFFIC REPORT

Sample Number
Y 2125

① Case Number: SAS 322Y

Sample Site Name/Code: Montrose, Chem Tanner Co.

② SAMPLE CONCENTRATION (Check One)
- X Low Concentration
- ___ Medium Concentration

③ SAMPLE MATRIX (Check One)
- X Water
- ___ Soil/Sediment

④ Ship To: Calif Analytical Lab, Inc 5895 Power Inn Rd Sacramento, Ca 95824
Attn: Paroi Mrad

Transfer Ship To:

⑤ Regional Office: 9

Sampling Personnel:
Steve Simanek
(Name)
415 974-8076
(Phone)

Sampling Date:
11-9-87
(Begin) (End)

⑥ For each sample collected specify number of containers used and mark volume level on each bottle.

	Number of Containers	Approximate Total Volume
Water (Extractable)	1	1/2 gal
Water (VOA)		
Soil/Sediment		
Water (Ext/VOA)		
Other		

⑦ Shipping Information
Federal Express
Name of Carrier
11-9-87
Date Shipped:
1156644523
Airbill Number:

⑧ Sample Description
- X Surface Water
- ___ Ground Water
- ___ Leachate
- ___ Mixed Media
- ___ Solids
- ___ Other (specify) ___

⑨ Sample Location

⑩ Special Handling Instructions:
(e.g., safety precautions, hazardous nature)

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BOE-C6-0176722

U.S. ENVIRONMENTAL PROTECTION AGENCY — CLP Sample Management Office

ORGANICS TRAFFIC REPORT

Sample Number: Y 2126

① Case Number: [illegible] 3224

Sample Site Name/Code: Montrose Chem. Torrance, Ca

② SAMPLE CONCENTRATION (Check One)
X Low Concentration
___ Medium Concentration

③ SAMPLE MATRIX (Check One)
X Water
___ Soil/Sediment

④ Ship To:
Calif. Analytical Lab, Inc.
5345 Power Inn Rd
Sacramento, Ca 95826
Attn: [illegible]

Transfer Ship To:

⑤ Regional Office: 9

Sampling Personnel:
Steve Sammonak (Name)
415 974-7406 (Phone)

Sampling Date:
11-9-92 (Begin) (End)

⑥ For each sample collected specify number of containers used and mark volume level on each bottle.

	Number of Containers	Approximate Total Volume
Water (Extractable)	1	1/2 gal.
Water (VOA)		
Soil/Sediment		
Water (Ext/VOA)		
Other		

⑦ Shipping Information

Federal Express
Name of Carrier

11-9-92
Date Shipped:

1051d645533
Airbill Number:

⑧ Sample Description

___ Surface Water ___ Mixed Media
___ Ground Water ___ Solids
___ Leachate ___ Other (specify) _____

⑨ Sample Location

⑩ Special Handling Instructions:
(e.g., safety precautions, hazardous nature)

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(1-32-)

BOE-C6-0176723

U.S. ENVIRONMENTAL PROTECTION AGENCY - EMSL Sample Management Office

Sample Number Y 2127

ORGANICS TRAFFIC REPORT

① Case Number: [illegible]

Sample Site Name/Code: Marina Cham Termination

② SAMPLE CONCENTRATION (Check One)

X Low Concentration
___ Medium Concentration

③ SAMPLE MATRIX (Check One)

✓ Water
___ Soil/Sediment

④ Ship To:

Calif Analytical Labs
5295 Power Inn Rd
Sacramento, Ca 95824
Attn: Bonnie Mraz

Transfer Ship To:

⑤ Regional Office: 7

Sampling Personnel:

Dave Sommerat
(Name)

(Phone)

Sampling Date:

11-1-92
(Begin) (End)

⑥ For each sample collected specify number of containers used and mark volume level on each bottle.

	Number of Containers	Approximate Total Volume
Water (Extractable)	1	½ gal.
Water (VOA)		
Soil/Sediment		
Water (Ext/VOA)		
Other		

⑦ Shipping Information

Federal Express
Name of Carrier

11-9-92
Date Shipped:

1056626533
Airbill Number:

⑧ Sample Description

X Surface Water ___ Mixed Media
___ Ground Water ___ Solids
___ Leachate ___ Other (specify) _____

⑨ Sample Location

⑩ Special Handling Instructions:
(e.g., safety precautions, hazardous nature)

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BOE-C6-0176724

U.S. ENVIRONMENTAL PROTECTION AGENCY HWT Sample Management Office
Post Office Box 818 Alexandria, VA 22313 (703) 557-2490

ORGANICS TRAFFIC REPORT

Sample Number
Y 2128

1752

① Case Number: SHO 322Y

Sample Site Name/Code: Montrose Chem Torrance CA

② SAMPLE CONCENTRATION (Check One)
X Low Concentration
___ Medium Concentration

③ SAMPLE MATRIX (Check One)
X Water
___ Soil/Sediment

④ Ship To:
Cutter Analytical Lab Inc
3895 Power Inn Rd
Sacramento, CA 95824
Attn: Bonnie McNeil
Transfer
Ship To:

⑤ Regional Office: 9
Sampling Personnel:
Steve Smanonak
(Name)
415 974-7406
(Phone)
Sampling Date:
11-9-92
(Begin) (End)

⑥ For each sample collected specify number of containers used and mark volume level on each bottle.

	Number of Containers	Approximate Total Volume
Water (Extractable)	1	1/2 gal
Water (VOA)		
Soil/Sediment		
Water (Ext/VOA)		
Other		

⑦ Shipping Information
Federal Express
Name of Carrier
11-9-92
Date Shipped:
1056228533
Airbill Number:

⑧ Sample Description
X Surface Water ___ Mixed Media
___ Ground Water ___ Solids
___ Leachate ___ Other (specify) _____

⑨ Sample Location

⑩ Special Handling Instructions:
(e.g., safety precautions, hazardous nature)

REGIONAL OFFICE FILE COPY

BOE-C6-0176725

U.S. ENVIRONMENTAL PROTECTION AGENCY CLP Sample Management Office
P.O. Box [illegible]

ORGANICS TRAFFIC REPORT

Sample Number
Y 2129

1175 81

① Case Number:
341 322Y

Sample Site Name/Code:
Montrose Chem
Torrance Ca.

② SAMPLE CONCENTRATION
(Check One)
X Low Concentration
___ Medium Concentration

③ SAMPLE MATRIX
(Check One)
X Water
___ Soil/Sediment

④ Ship To:
Calif. Analytical Lab.
5895 Power Inn Rd
Sacramento, Ca 95824
Attn: Sandie Mapel

Transfer
Ship To:

⑤ Regional Office: 9
Sampling Personnel:
Jane Simonak
(Name)
415 974-7406
(Phone)
Sampling Date:
11-1-82
(Begin) (End)

⑥ For each sample collected specify number of containers used and mark volume level on each bottle.

	Number of Containers	Approximate Total Volume
Water (Extractable)	1	1/2 gal
Water (VOA)		
Soil/Sediment		
Water (Ext/VOA)		
Other		

⑦ Shipping Information
Federal Express
Name of Carrier
11-1-82
Date Shipped:
1056d8533
Airbill Number:

⑧ Sample Description
X Surface Water ___ Mixed Media
___ Ground Water ___ Solids
___ Leachate ___ Other (specify) _____

⑨ Sample Location

⑩ Special Handling Instructions:
(e.g., safety precautions, hazardous nature)

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-1a-1

U.S. ENVIRONMENTAL PROTECTION AGENCY / EMSL Sample Management Office
P.O. Box 818, Alexandria, VA 22313 (703-557-2444)

ORGANICS TRAFFIC REPORT

Sample Number
Y 2130

1 Case Number: 332Y

Sample Site Name/Code: Montrose Chem Torrance Ca

2 SAMPLE CONCENTRATION (Check One)
X Low Concentration
___ Medium Concentration

3 SAMPLE MATRIX (Check One)
X Water
___ Soil/Sediment

4 Ship To: Calif. Analytical Lab, Inc 5845 River Road Sacramento, Ca 95841 Attn: Barrie Nickel
Transfer
Ship To:

5 Regional Office: 7
Sampling Personnel: Steve Armanak
(Name)
415 744-1076
(Phone)
Sampling Date: 11-2-87
(Begin) (End)

6 For each sample collected specify number of containers used and mark volume level on each bottle.

	Number of Containers	Approximate Total Volume
Water (Extractable)	1	½ gl
Water (VOA)		
Soil/Sediment		
Water (Ext/VOA)		
Other		

7 Shipping Information
Federal Express
Name of Carrier
11-9-87
Date Shipped:
105 610 5533
Airbill Number:

8 Sample Description
___ Surface Water ___ Mixed Media
___ Ground Water ___ Solids
___ Leachate ___ Other (specify) _____

9 Sample Location

10 Special Handling Instructions:
(e.g., safety precautions, hazardous nature)

REGIONAL OFFICE FILE COPY

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U.S. ENVIRONMENTAL PROTECTION AGENCY - HWI Sample Management Office

ORGANICS TRAFFIC REPORT

Sample Number
Y 2131

1755

① Case Number:
SAS 2224

Sample Site Name/Code:
[illegible]

② SAMPLE CONCENTRATION
(Check One)
X Low Concentration
___ Medium Concentration

③ SAMPLE MATRIX
(Check One)
X Water
___ Soil/Sediment

④ Ship To:
Mid-Analytical Lab Inc
5895 Power Inn Rd
[illegible]
Attn: Bonnie Urmal
Transfer
Ship To:

⑤ Regional Office: 9
Sampling Personnel:
[illegible]
(Name)
415 [illegible]
(Phone)
Sampling Date:
[illegible]
(Begin) (End)

⑥ For each sample collected specify number of containers used and mark volume level on each bottle.

	Number of Containers	Approximate Total Volume
Water (Extractable)	1	1/2 gal
Water (VOA)		
Soil/Sediment		
Water (Ext/VOA)		
Other		

⑦ Shipping Information
Federal Express
Name of Carrier
[illegible]
Date Shipped:
[illegible]
Airbill Number:

⑧ Sample Description
X Surface Water ___ Mixed Media
___ Ground Water ___ Solids
___ Leachate ___ Other (specify) _____

⑨ Sample Location

⑩ Special Handling Instructions:
(e.g., safety precautions, hazardous nature)

REGIONAL OFFICE FILE COPY

ENVIRONMENTAL PROTECTION AGENCY
Office of Enforcement

REGION 9
215 Fremont Street
San Francisco, California 94105

CHAIN OF CUSTODY RECORD

PROJ NO. [illegible] | PROJECT NAME: Montrose Chemical

SAMPLERS (Signature): [illegible]

STA NO	DATE	TIME	COMP	GRAB	STATION LOCATION	NO. OF CONTAINERS	REMARKS
	11 FEB			/	Y-2132	1	Soil sample - 8 oz glass jar
				/	Y-2133	1	
				/	Y-2134	1	
				/	Y-2135	1	
				/	Y-2136	1	
				/	Y-2137	1	
				/	Y-2138	1	
				/	Y-2139	1	
				/	Y-16162	1	
				/	Y-1663	1	

Relinquished by: (Signature)	Date / Time	Received by: (Signature)	Relinquished by: (Signature)	Date / Time	Received by: (Signature)
[illegible]	11 FEB 1430	[illegible]			
Relinquished by (Signature)	Date / Time	Received by: (Signature)	Relinquished by: (Signature)	Date / Time	Received by: (Signature)
Relinquished by: (Signature)	Date / Time	Received for Laboratory by: (Signature)	Date / Time	Remarks	

Distribution: Original Accompanies Shipment; Copy to Coordinator Field Files

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PLEASE COMPLETE ALL INFORMATION IN THE 5 BLOCKS OUTLINED IN ORANGE
SEE BACK OF FORM SET FOR COMPLETE PREPARATION INSTRUCTIONS

AIRBILL NUMBER 105688544

YOUR FEDERAL EXPRESS ACCOUNT NUMBER

DATE

FROM (Your Name)

TO (Recipient's Name)

If Held For Pick-Up or Saturday Delivery, Recipient's Phone Number

COMPANY

DEPARTMENT/FLOOR NO

COMPANY

DEPARTMENT/FLOOR NO

STREET ADDRESS

STREET ADDRESS (P.O. BOX NUMBERS ARE NOT DELIVERABLE)

CITY

STATE

CITY

STATE

ZIP

ZIP

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BOE-C6-0176730

U.S. ENVIRONMENTAL PROTECTION AGENCY - HWE Sample Management Office
P.O. Box 818, Alexandria, Virginia 22313 (703) 557-2490 FTS 557-2490

ORGANICS TRAFFIC REPORT

Sample Number
Y 1662

1753

① Case Number: SAS 3224

Sample Site Name/Code: Montrose Chem Torrance Ca

② SAMPLE CONCENTRATION (Check One)
___ Low Concentration
X Medium Concentration

③ SAMPLE MATRIX (Check One)
___ Water
X Soil/Sediment

④ Ship To:
Cobalt Analytical Lab. Inc
5895 Power Inn Rd
Sacramento Ca 95824
Attn: Bonnie M. Neil

Transfer Ship To:

⑤ Regional Office: 9

Sampling Personnel:
Steve Simanonok
(Name)
415 974-7406
(Phone)

Sampling Date:
11-10-82
(Begin) (End)

⑥ For each sample collected specify number of containers used and mark volume level on each bottle.

	Number of Containers	Approximate Total Volume
Water (Extractable)		
Water (VOA)		
Soil/Sediment	1	8 OZ
Water (Ext/VOA)		
Other		

⑦ Shipping Information

Federal Express
Name of Carrier

11-10-82
Date Shipped:

1056688544
Airbill Number:

⑧ Sample Description

___ Surface Water ___ Mixed Media
___ Ground Water ___ Solids
___ Leachate X Other (specify) Soil

⑨ Sample Location

1

⑩ Special Handling Instructions:
(e.g., safety precautions, hazardous nature)

DO NOT USE DDE ONLY

4-37-

REGIONAL OFFICE FILE COPY

U.S. ENVIRONMENTAL PROTECTION AGENCY - CLP Sample Management Office
P.O. Box 818 Alexandria, VA 22313 (703) 557-2490

ORGANICS TRAFFIC REPORT

Sample Number
Y 1663

1750

(1) Case Number:
SAS 322Y

Sample Site Name/Code:
Montrose Chem
Torrance, Ca

(2) SAMPLE CONCENTRATION
(Check One)
X Low Concentration
X Medium Concentration

(3) SAMPLE MATRIX
(Check One)
___ Water
X Soil/Sediment

(4) Ship To:
Calif. Analytical Lab, Inc.
5845 Power Inn Rd
Sacramento, Ca 95824
Attn: Bonnie Mallet

Transfer
Ship To:

(5) Regional Office: 9
Sampling Personnel:
Steve Leonard
(Name)
415-744-7136
(Phone)
Sampling Date:
11-10-92
(Begin) (End)

(6) For each sample collected specify number of containers used and mark volume level on each bottle.

	Number of Containers	Approximate Total Volume
Water (Extractable)		
Water (VOA)		
Soil/Sediment	1	8 oz
Water (Ext/VOA)		
Other		

(7) Shipping Information
Federal Express
Name of Carrier
11-10-92
Date Shipped:
105608544
Airbill Number:

(8) Sample Description
___ Surface Water ___ Mixed Media
___ Ground Water ___ Solids
___ Leachate X Other (specify) Soil

(9) Sample Location

(10) Special Handling Instructions:
(e.g., safety precautions, hazardous nature)

REGIONAL OFFICE FILE COPY

U.S. ENVIRONMENTAL PROTECTION AGENCY / HW Sample Management Office

ORGANICS TRAFFIC REPORT

Sample Number
Y 2132

① **Case Number:**
[illegible] 2224

Sample Site Name/Code:
[illegible]

② **SAMPLE CONCENTRATION**
(Check One)
___ Low Concentration
_X_ Medium Concentration

③ **SAMPLE MATRIX**
(Check One)
___ Water
_X_ Soil/Sediment

④ **Ship To:**
Calif. Analytical Labs Inc.
5249 Fair Oaks Blvd
Sacramento, Ca 95824
Attn: Bonnie McNeil
Transfer
Ship To:

⑤ **Regional Office:** 9
Sampling Personnel:
[illegible]
(Name)
[illegible] 4460
(Phone)
Sampling Date:
(Begin) (End)

⑥ **For each sample collected specify number of containers used and mark volume level on each bottle.**

	Number of Containers	Approximate Total Volume
Water (Extractable)		
Water (VOA)		
Soil/Sediment	1	
Water (Ext/VOA)		
Other		

⑦ **Shipping Information**
[illegible]
Name of Carrier
[illegible]
Date Shipped:
[illegible]
Airbill Number:

⑧ **Sample Description**
___ Surface Water ___ Mixed Media
___ Ground Water ___ Solids
___ Leachate _X_ Other (specify) SAM

⑨ **Sample Location**

⑩ **Special Handling Instructions:**
(e.g., safety precautions, hazardous nature)

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(- - -)

U.S. ENVIRONMENTAL PROTECTION AGENCY/CLP Sample Management Office

ORGANICS TRAFFIC REPORT

Sample Number
Y 2133

① Case Number:
SAS 3224

Sample Site Name/Code:
[illegible]

② SAMPLE CONCENTRATION
(Check One)
___ Low Concentration
_X_ Medium Concentration

③ SAMPLE MATRIX
(Check One)
___ Water
_X_ Soil/Sediment

④ Ship To:
Calif Analytical [illegible]
5845 Power Inn Rd
Sacramento, Ca 95824
Attn: Bonnie McNeil
Transfer
Ship To:

⑤ Regional Office: 1
Sampling Personnel:
[illegible]
(Name)
[illegible]
(Phone)
Sampling Date:
[illegible]
(Begin) (End)

⑥ For each sample collected specify number of containers used and mark volume level on each bottle.

	Number of Containers	Approximate Total Volume
Water (Extractable)		
Water (VOA)		
Soil/Sediment	1	[illegible]
Water (Ext/VOA)		
Other		

⑦ Shipping Information
[illegible]
Name of Carrier
[illegible]
Date Shipped:
[illegible]
Airbill Number:

⑧ Sample Description
___ Surface Water ___ Mixed Media
___ Ground Water ___ Solids
___ Leachate _X_ Other (specify) Soil

⑨ Sample Location

⑩ Special Handling Instructions:
(e.g., safety precautions, hazardous nature)

REGIONAL OFFICE FILE COPY

BOE-C6-0176734

U.S. ENVIRONMENTAL PROTECTION AGENCY — Contract Laboratory Program — Sample Management Office

ORGANICS TRAFFIC REPORT

Sample Number: Y 2134

1762

① **Case Number:** SAS 2224

Sample Site Name/Code: Montrose Chem. Torrance, Ca

② **SAMPLE CONCENTRATION** (Check One)

___ Low Concentration
X Medium Concentration

③ **SAMPLE MATRIX** (Check One)

___ Water
X Soil/Sediment

④ **Ship To:**

Cal. Analytical Labs Inc.
5845 Power Inn Rd
Sacramento Ca. 95828
Attn: Bonnie Weilert

Transfer Ship To:

⑤ **Regional Office:** 1

Sampling Personnel:

Steve Marshall
(Name)

415 744-1076
(Phone)

Sampling Date:

(Begin) (End)

⑥ **For each sample collected specify number of containers used and mark volume level on each bottle.**

	Number of Containers	Approximate Total Volume
Water (Extractable)		
Water (VOA)		
Soil/Sediment	1	2
Water (Ext/VOA)		
Other		

⑦ **Shipping Information**

Federal Express
Name of Carrier

Date Shipped:

Airbill Number:

⑧ **Sample Description**

___ Surface Water ___ Mixed Media
___ Ground Water ___ Solids
___ Leachate X Other (specify) Soil

⑨ **Sample Location**

⑩ **Special Handling Instructions:**
(e.g., safety precautions, hazardous nature)

(-57-)

REGIONAL OFFICE FILE COPY

U.S. ENVIRONMENTAL PROTECTION AGENCY — CLP Sample Management Office

ORGANICS TRAFFIC REPORT

Sample Number: Y 2135

1726

① Case Number: SAS 3224

Sample Site Name/Code: Montrose Chem Torrance Ca

② SAMPLE CONCENTRATION (Check One)

___ Low Concentration
X Medium Concentration

③ SAMPLE MATRIX (Check One)

___ Water
X Soil/Sediment

④ Ship To: Calif Analytical Labs Inc 5995 Power Inn Rd Sacramento, Ca 95724 Attn: Bonnie McHead

Transfer Ship To:

⑤ Regional Office: 4

Sampling Personnel:

Steve Imamoto (Name)

415 744-2405 (Phone)

Sampling Date:

(Begin) (End)

⑥ For each sample collected specify number of containers used and mark volume level on each bottle.

	Number of Containers	Approximate Total Volume
Water (Extractable)		
Water (VOA)		
Soil/Sediment	1	4 oz
Water (Ext/VOA)		
Other		

⑦ Shipping Information

Federal Express Name of Carrier

11-13-87 Date Shipped:

[illegible] Airbill Number:

⑧ Sample Description

___ Surface Water ___ Mixed Media
___ Ground Water ___ Solids
___ Leachate X Other (specify) Soil

⑨ Sample Location

⑩ Special Handling Instructions: (e.g., safety precautions, hazardous nature)

REGIONAL OFFICE FILE COPY

BOE-C6-0176736

U.S. ENVIRONMENTAL PROTECTION AGENCY, EPA Sample Management Office

ORGANICS TRAFFIC REPORT

Sample Number
Y 2136

1 Case Number:
SAS 3224

Sample Site Name/Code:
Montrose Chem
Torrance Ca

2 SAMPLE CONCENTRATION
(Check One)
___ Low Concentration
X Medium Concentration

3 SAMPLE MATRIX
(Check One)
___ Water
X Soil/Sediment

4 Ship To:
Caly Analytical L.L. Inc
5885 Power Inn Rd
Sacramento, Ca 95824
Attn: Emmi Mercado
Transfer
Ship To:

5 Regional Office: 9
Sampling Personnel:
Steve Emmerman
(Name)
415 974 7406
(Phone)
Sampling Date:
(Begin) (End)

6 For each sample collected specify number of containers used and mark volume level on each bottle.

	Number of Containers	Approximate Total Volume
Water (Extractable)		
Water (VOA)		
Soil/Sediment	1	
Water (Ext/VOA)		
Other		

7 Shipping Information
Federal Express
Name of Carrier
11-10-92
Date Shipped:
[illegible]
Airbill Number:

8 Sample Description
___ Surface Water ___ Mixed Media
___ Ground Water ___ Solids
___ Leachate X Other (specify) Soil

9 Sample Location

10 Special Handling Instructions:
(e.g., safety precautions, hazardous nature)

REGIONAL OFFICE FILE COPY

U.S. ENVIRONMENTAL PROTECTION AGENCY - EMSL Sample Management Office

ORGANICS TRAFFIC REPORT

Sample Number
Y 2137

(1) Case Number:
SHS 3224

Sample Site Name/Code:
Montrose Chem
Torrance Ca

(2) SAMPLE CONCENTRATION
(Check One)
___ Low Concentration
X Medium Concentration

(3) SAMPLE MATRIX
(Check One)
___ Water
X Soil/Sediment

(4) Ship To:
Calif Analytical Lab, Inc
5845 Power Inn Rd
Sacramento Ca 95824
Attn: Bonnie Mc Q.

Transfer
Ship To:

(5) Regional Office: 9
Sampling Personnel:
Edene Armendariz
(Name)
415 744-3406
(Phone)
Sampling Date:
11-5-87
(Begin) (End)

(6) For each sample collected specify number of containers used and mark volume level on each bottle.

	Number of Containers	Approximate Total Volume
Water (Extractable)		
Water (VOA)		
Soil/Sediment	1	8 oz
Water (Ext/VOA)		
Other		

(7) Shipping Information
Fedex Express
Name of Carrier
11-6-87
Date Shipped:
1-Express-Day
Airbill Number:

(8) Sample Description
___ Surface Water ___ Mixed Media
___ Ground Water ___ Solids
___ Leachate X Other (specify) Soil

(9) Sample Location

(10) Special Handling Instructions:
(e.g., safety precautions, hazardous nature)

(- 5% -)

REGIONAL OFFICE FILE COPY

U.S. ENVIRONMENTAL PROTECTION AGENCY CLP Sample Management Office

ORGANICS TRAFFIC REPORT

Sample Number
Y 2139

① Case Number:
SAS 4224

Sample Site Name/Code:
Montrose Chem
Torrance Ca.

② SAMPLE CONCENTRATION
(Check One)
___ Low Concentration
X Medium Concentration

③ SAMPLE MATRIX
(Check One)
___ Water
X Soil/Sediment

④ Ship To:
Cal Analytical Lab. Inc
5384 Peachtree Rd
Sacramento, Ca.
Attn: Bonnie Walker

Transfer
Ship To:

⑤ Regional Office: 9
Sampling Personnel:
Elena Armanino
(Name)
415 974-7406
(Phone)
Sampling Date:
11-3-92
(Begin) (End)

⑥ For each sample collected specify number of containers used and mark volume level on each bottle.

	Number of Containers	Approximate Total Volume
Water (Extractable)		
Water (VOA)		
Soil/Sediment	1	8 oz
Water (Ext/VOA)		
Other		

⑦ Shipping Information
Federal Express
Name of Carrier
11-4-92
Date Shipped:
1053662541
Airbill Number:

⑧ Sample Description
___ Surface Water ___ Mixed Media
___ Ground Water ___ Solids
___ Leachate X Other (specify) soil

⑨ Sample Location

⑩ Special Handling Instructions:
(e.g., safety precautions, hazardous nature)

REGIONAL OFFICE FILE COPY

BOE-C6-0176739

U.S. ENVIRONMENTAL PROTECTION AGENCY — Sample Management Office

ORGANICS TRAFFIC REPORT

Sample Number: Y 2139

(1) Case Number: DA- 3227

Sample Site Name/Code: Montrose Chem Torrance Co

(2) SAMPLE CONCENTRATION (Check One)

___ Low Concentration
X Medium Concentration

(3) SAMPLE MATRIX (Check One)

___ Water
X Soil/Sediment

(4) Ship To:

Calif Analytical Labs Inc
5895 Pkwy Dr. #C
Sacramento, Ca 95823
Attn: Bonnie Mills

Transfer Ship To:

(5) Regional Office: 9

Sampling Personnel:

Steve Simonak
(Name)

415 744-1406
(Phone)

Sampling Date:

11-9-87
(Begin) (End)

(6) For each sample collected specify number of containers used and mark volume level on each bottle.

	Number of Containers	Approximate Total Volume
Water (Extractable)		
Water (VOA)		
Soil/Sediment	1	4 oz
Water (Ext/VOA)		
Other		

(7) Shipping Information

Federal Express
Name of Carrier

11-9-87
Date Shipped:

[illegible]
Airbill Number:

(8) Sample Description

___ Surface Water ___ Mixed Media
___ Ground Water ___ Solids
___ Leachate X Other (specify) Soil

(9) Sample Location

(10) Special Handling Instructions:
(e.g., safety precautions, hazardous nature)

REGIONAL OFFICE FILE COPY

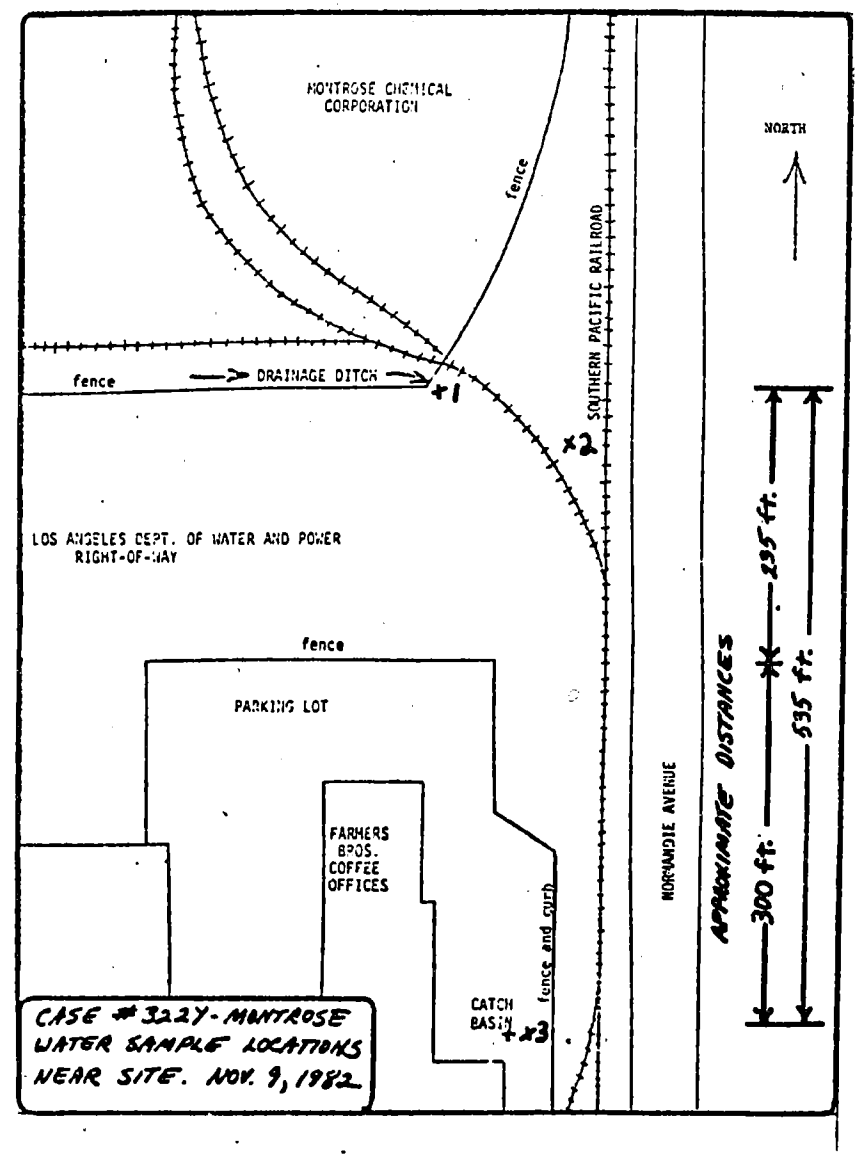
BOE-C6-0176740

WATER SAMPLES NEAR SITE - PARTS PER BILLION[1]

Location	Sample Number	DDE[2]	DDD[3]	DDT[4]	Total DDT and Metabolites[5]
1	2123	29.3	37	143	209.3
1	2124	77	49	234	360
1(Blank)	2130	<0.1	<0.1	<0.1	<0.1
2	2131	115	37	543	695
3	2122	49	41	393	483
3	2125	34	32	178	244
3	2126	31	29	127	187

notes:

1. ug/l
2. DDE = o,p-DDE + p,p-DDE
3. DDD = o,p-DDD + p,p-DDD
4. DDT = o,p-DDT + p,p-DDT
5. Total DDT and metabolites = DDE + DDD + DDT



WATER SAMPLES DOWNSTREAM - PARTS PER BILLION[1]

Location	Sample Number	DDE[2]	DDD[3]	DDT[4]	Total DDT and Metabolites[5]
5	2128	1.9	.64	14.75	17.29
6	2129	(sample broken in shipment)			

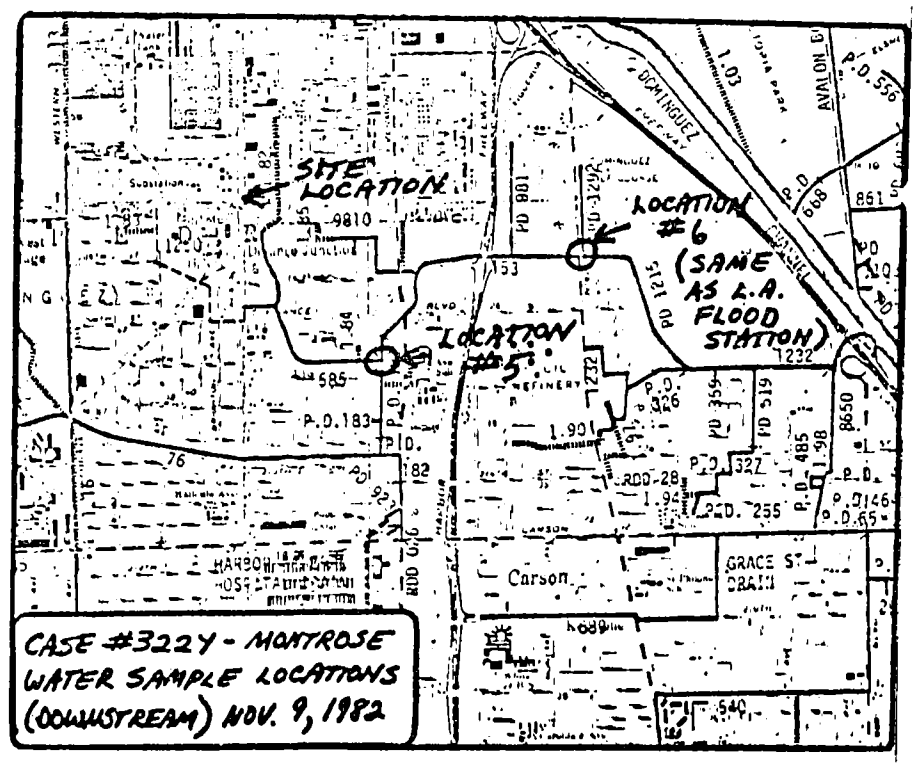
L. A. FLOOD CONTROL DISTRICT SAMPLE ANALYSIS
1977 - 1982

- Mean Concentrations -

Location	DDE	DDD	DDT	Total DDT and Metabolites
6 (dry weather[6])	.34	.11	.30	.75
6 (wet weather[7])	.60	.38	4.90	5.88

notes:

1. ug/l
2. DDE = o,p-DDE + p,p-DDE
3. DDD = o,p-DDD + p,p-DDD
4. DDT = o,p-DDT + p,p-DDT
5. Total DDT and metabolites = DDE + DDD + DDT
6. Mean concentrations for 50-51 samples at this location during dry weather conditions
7. Mean concentrations for 16-22 samples at this location during wet weather conditions



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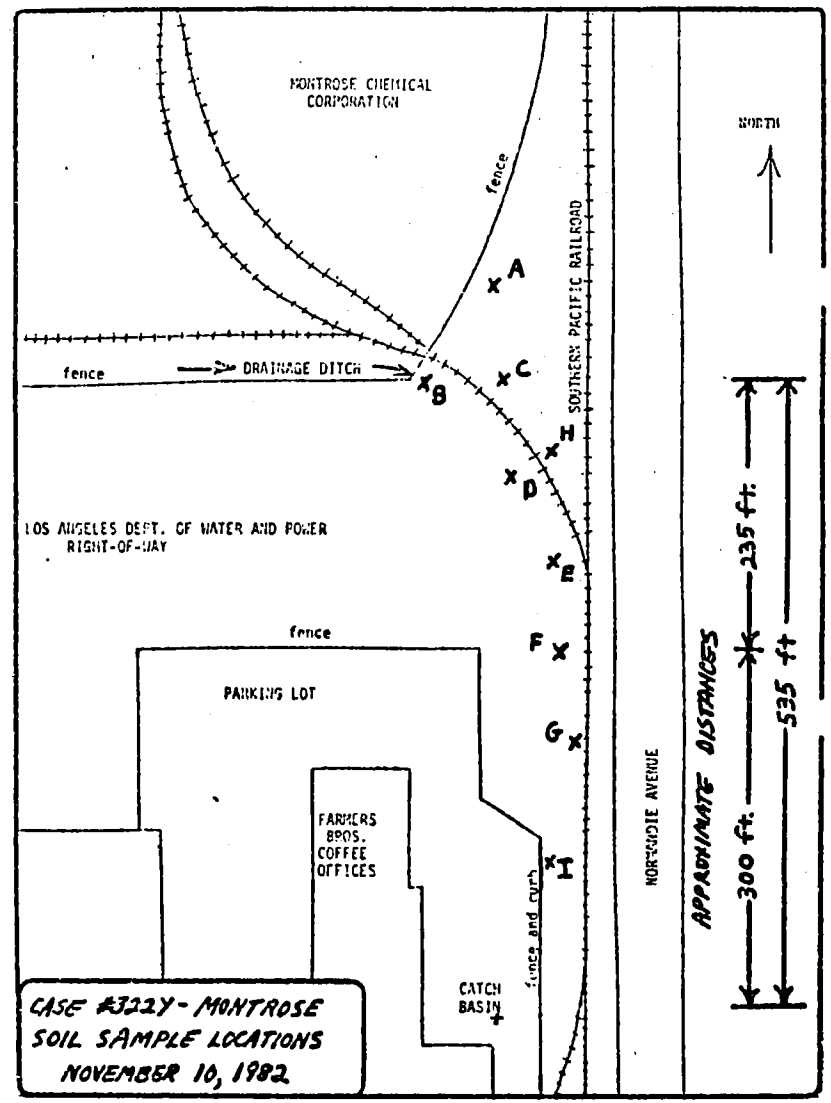
SOIL SAMPLES - PARTS PER MILLION[1]

Location	Sample Number	DDE[2]	DDD[3]	DDT[4]	Total DDT and Metabolites[5]
A	2132	143	39	1,733	1,915
B	2133	116.9	178	1,680	1,974.9
C	2134	4.64	<2	19.51	24.15
D	2135	16	11.9	201	228.9
E	2136	131	80	1,035	1,246
F	2137	14.1	7.9	121.4	143.4
G	2138	35.1	10	207	252.1
H	2139	33.2	<2	145	178.2
H	1662	58.7	11	305	374.7
I	1663	75.9	33	390	498.9

Notes:

1. mg/kg calculated on wet weight basis
2. DDE = o,p-DDE + p,p-DDE
3. DDD = o,p-DDD + p,p-DDD
4. DDT = o,p-DDT + p,p-DDT
5. Total DDT and metabolites = DDE + DDD + DDT



REPORT ON EVALUATION OF THE

Case# 322Y Montrose Chemical data

by

OFFICE OF TECHNICAL & SCIENTIFIC ASSISTANCE

EPA REGION 9

215 FREMONT STREET

SAN FRANCISCO, CA 94105

1/12/83
Date

Reviewer (415) 974-7431 (FTS 454

-6-

BOE-C6-0176744

Case #3224
Reviewer, K. Wong, G. Muth
Date: 1/10/83

Pesticide Fraction
20 samples

SUMMARY

A. General Comments:

1. The data arrived in 3 separate portions:
   1. Original quantitation data NOV. 22, 1982
   2. Qualitative confirmation DEC. 6, 1982
   3. Quantitative confirmation DEC. 20, 1982

2. The TDE* and DDE (related compounds) data meet the quality assurance requirements and are considered accurate for the aliquat analyzed.
   DDT standards for the original quantitation data package were not analyzed the same day as the samples, and the accuracy could not be determined. Therefore, re-extraction and re-analysis of several samples were requested so that the ratio of DDT to the related compounds could be confirmed.

   The ratio for the original quantitation was calculated to be 73.5%; and was calculated to be 68.5% for the quantitative confirmation. These ratios are similar within the degree of variation of this analysis. Therefore, based upon these ratios, the accuracy of the original DDT quantitation values is confirmed for all samples.

3. The quantitative confirmation values for all compounds reported averaged 45% of the original quantitation. This is due to at least two factors:
   1) The samples were stored approximately one month between extractions and analyses. This would allow time for degradation to occur.
   2) The sediment was stirred up and allowed to settle prior to aliquoting for each extraction. The concentrations of DDT are partially dependent on the quantity of sediment included ineach aliquat. The settling time for the original extraction was not specified; however, the settling time for the confirmation run was 4 hours. Thus, a significant difference in concentration could be expected due to the quantity of sediment included in each aliquat.

4. The practice of allowing the sediments to settle out for water samples prior to aliquation (see item 3) will significantly underestimate the DDT and related compounds of a stream. This is due to the DDT adsorbing on the sediment particles. It is therefore expected that the actual quantity of DDT carried by the stream is greater than that measured by the original quantitation.

*DDD

-6/-

B. Precision, as measured by duplicate analysis, is considered acceptable.

1. Original quantitation data
   water= 43 RPD (relative percent difference)
   soil= 20.8 RPD

2. Quantitative confirmation data
   water= 8.2 RPD

C. Accuracy as measured by Matrix Spikes meets criteria for all analyses reported.

1. Quantitative differences are explained (A3) in terms of sample degradation and differences in sediment loading.

D. Confirmation:

1. The reported compounds were confirmed qualitatively by second column GC analysis.

2. The quantitative ratios of DDT to related compounds were confirmed by additional extraction and analysis.

E. Validity:

1. This data is valid.

2. The original quantitation data (Nov. 22, 1982) may be used for official reports and enforcement purposes.

PAUL A. TAYLOR, Ph.D.
PRESIDENT

CHARLES J. SODERQUIST, Ph.D
VICE PRESIDENT

ANTHONY S. WONG, Ph.D
VICE PRESIDENT

RUBY A. ULRICH
SECRETARY-TREASURER

California Analytical Laboratories, Inc.

5885 POWER INN ROAD
SACRAMENTO, CALIFORNIA 95824
(916) 381-5105

November 22, 1982

Dick Thacker
Viar & Company
114 North Columbus
Alexandria, VA

Dear Dick:

Enclosed are the results of our analysis of nine water and ten sediment samples received as Case 322Y on November 10 and 11, 1982 for the ortho and para isomers of DDE, DDD and DDT.

The water samples were analyzed per EPA Method 608. The sediments were analyzed per the method in contract No. 68-01-6407.

Results are given in Tables I, II and III, attached.

If you have any questions, please do not hesitate to call.

Sincerely,

Charles J. Soderquist, PhD
Vice President
Agricultural and Environmental Chemistry

CJS:nc

TABLE I
Water Samples

		µg/L (ppb) found					
CAL I.D.	EPA I.D.	o,p-DDE	p,p-DDE	o,p-DDD	p,p-DDD	o,p-DDT	p,p-DDT
S1663	Y2122	11	38	20	21	43	350
S1664	Y2123	7.3	22	26	11	23	120
S1664D	Y2123 dup	9.5	28	35	18	42	260
S1665	Y2124	14	63	33	16	24	210
S1666	Y2125	9.0	25	15	17	18	160
S1667	Y2126	8.0	23	13	16	17	110
S1668	Y2127	<0.1	<0.1	<0.1	<0.1	<0.1	0.63
S1668MS[a]	Y2127spike	<0.1	<0.1	<0.1	<0.1	7.0	9.5
S1669	Y2128	<0.1	1.9	0.16	0.48	0.75	14
S1670	Y2130	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
S1671	Y2131	15	100	22	15	43	500
S1663MB	-----	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1

Notes: [a] Spiked at 10 µg/L each o,p-DDT and p,p-DDT.

TABLE II

Soil Samples

CAL I.D.	EPA I.D.	mg/Kg (ppm) found[b] o,p-DDE	p,p-DDE	o,p-DDD	p,p-DDD	o,p-DDT	p,p-DDT	Percent Moisture
S1680	Y1662	7.7	51	<2.0	11	35	270	29
S1681	Y1663	5.9	70	11	22	30	360	26
S1682	Y2132	11	132	<2.0	39	133	1,600	47
S1683	Y2133	6.9	110	68	110	180	1,500	34
S1684	Y2134	0.34	4.3	<2.0	<2.0	0.51	19	23
S1684MS[a]	Y2134spike	---	---	---	---	93	140	--
S1685	Y2135	<1.0	16	6.3	5.6	11	190	33
S1685D	Y2135 dup	<1.0	15	2.1	5.4	11	220	34
S1686	Y2136	11	120	41	39	85	950	39
S1687	Y2137	1.1	13	3.5	4.4	7.4	114	31
S1688	Y2138	2.1	33	<2.0	10	17	190	27
S1689	Y2139	5.2	28	<2.0	<2.0	15	130	36
S1690MB	-----	<1.0	<1.0	<2.0	<2.0	<2.0	<2.0	--

Notes: [a] Spiked at 150 mg/Kg each o,p-DDT and p,p-DDT.

[b] On wet weight basis.

TABLE III
Quality Assurance

A. Spiked Samples

			o,p-DDT			p,p-DDT		
CAL I.D.	EPA I.D.	Matrix	added	found	%	added	found	%
S1668	Y2127	water	0	<0.1 ppb	--	0	0.63 ppb	--
S1668MS	Y2127spike	water	10 ppb	7.0 ppb	70	10 ppb	9.5 ppb	89
S1684	Y2134	soil	0	0.51ppm	--	0	19 ppm	--
S1684MS	Y2134spike	soil	150 ppm	93 ppm	62	150 ppm	140 ppm	81

B. Duplicate Samples

Refer to Tables I and II.

PAUL A. TAYLOR, Ph.D
PRESIDENT

CHARLES J. SODERQUIST, Ph.D
VICE PRESIDENT

ANTHONY S. [illegible], Ph.D
VICE PRESIDENT

RUBY A. ULRICH
SECRETARY/TREASURER

California Analytical Laboratories, Inc.

5895 POWER INN ROAD
SACRAMENTO, CALIFORNIA 95824
(916) 381-5105

December 6, 1982

Dick Thacker
Viar & Company
114 North Columbus Street
Alexandria, Virginia

Dear Dick:

Enclosed is our amended report for the nine water and ten sediment samples received as Case 322Y and originally reported on November 22, 1982.

Please discard the previous report.

At the request of Jerry Muth (Region IX EPA) on November 30, we have performed second-column (3% SP2100) EC-GC analyses of the original extracts. The resulting chromatograms are attached as Data Sets III & IV (standards and samples). The original chromatograms are attached as Data Sets I & II. Please note that an invoice for this accitional work will be sent later.

The water samples were analyzed using a modification of EPA Method 608. In brief, 800 mL aliquots were extracted with dichloromethane, the extracts concentrated, exchanged to isooctane, and analyzed by EC-GC using a 1.8 m by 2 mm (id) glass column containing 1.5% OV-17/1.95% QF1 held at 200°. Sample responses were compared to the averaged response of authentic (EPA) reference standards of the p,p and o,p isomers of DDE, DDD and DDT injected at 20 to 60 ng/mL concentrations. Sample dilutions were chosen to give peak responses within a factor of five of the standards; EC linearity was demonstrated for this range. As mentioned above, the extracts were later analyzed by EC-GC using a 2.5 m by 2mm (id) glass column containing 3% SP2100 held at 200°; these analyses were qualitative only. All initial identifications were confirmed with the exception of o,p-DDD which, because it coeluted with p,p-DDE (a major peak in most samples), could not be confirmed.

The sediment samples were analyzed using a modification of the method detailed in contract #68-01-6407. In brief, accurately weighed 1-2 g subsamples were mixed with 800 mL of pure water and then extracted and analyzed as outlined above for the water samples.

-47-

The following comments apply:

1). Chromatograms of standard injections are not available for some of the days on which samples were injected. The EC-GC used was reserved for this case and was not altered during the project. The average percent standard deviation of the response of the six reference standards was only 9.1 percent over the period of analysis.

2). Water sample S1664 (Y2123), which was analyzed in duplicate, contained a large amount of suspended sediment. The higher values for both DDT isomers in S1664D (Table I) is probably due to the greater amount of sediment which was present in the second aliquot decanted from the sample container.

3). The o,p-DDD and o,p-DDE results (Tables I & II) appear to be somewhat high relative to the corresponding p,p isomers when the chromatograms are examined. These peaks were generally small and may have been incorrectly processed by the data system. While the presence of o,p-DDE was confirmed in all cases, o,p-DDD could not be due to its coelution with p,p-DDE on the SP2100 column.

If you have any questions, please do not hesitate to call.

Sincerely,

Charles J. Soderquist, PhD
Vice President
Agricultural and Environmental Chemistry

CJS:nc

PAUL A. TAYLOR, Ph.D
PRESIDENT

CHARLES J. SODERQUIST, Ph.D
VICE PRESIDENT

ANTHONY S. WONG, Ph.D
VICE PRESIDENT

RUBY A. ULRICH
SECRETARY/TREASURER

California Analytical Laboratories, Inc.

5895 POWER INN ROAD
SACRAMENTO, CALIFORNIA 95824
(916) 381-5105

December 20, 1982

Dick Thacker
Viar & Company
114 North Columbus Street
Alexandria, VA

Dear Dick:

As requested by Jerry Muth (Region IX, EPA) and approved by Linda Haas (Viar & Company) during a conference phone call on December 9, 1982, we have reanalyzed remaining portions of the following water samples originally received on November 10 & 11, 1982 as Case 322Y.

CAL I.D.	EPA I.D.
S1663-2	Y2122
S1664-2	Y2123
S1665-2	Y2124
S1666-2	Y2125
S1667-2	Y2126
S1670-2	Y2130

The remaining water/sediment samples were shaken and about 60 mL of each (plus an additional 60 mL of S1663-2 for S1663D-2 and 60 mL of S1670-2 for S1670MS-2) was poured into a 50 mL graduated cylinder. After allowing the bulk of the sediment to settle (4 hours), 40 mL portions of all samples except S1670-2 and S1670MS-2 (50 mL each) were placed in 125 separatory funnels and extracted with two 10 mL portions of dichloromethane. The pooled extracts were concentrated under nitrogen, exchanged to isooctane and analyzed by electron-capture gas chromatography using a 6' by 2mm 1.5% OV-17/1.95% QF-1 column held at 200°. Sample peak height responses were compared to those of authentic (EPA) reference standards for all six isomers.

Results are given in Table I. Quality Assurance is summarized in Table II. Chromatograms are attached.

If you have any questions, please feel free to call.

Sincerely,

Charles J. Soderquist, PhD
Vice President
Agricultural and Environmental Chemistry

CJS:nc

-62-

TABLE I

Results

		µg/L (ppb) found					
CAL I.D.	EPA I.D.	o,p-DDE	p,p-DDE	o,p-DDD	p,p-DDD	o,p-DDT	p,p-DDT
S1663-2	Y2122	1.7	13	5.3	6.3	17	43
S1663D-2	Y2122 dup	1.8	10	4.8	5.8	15	43
S1664-2	Y2123	2.3	16	4.8	7.5	24	103
S1665-2	Y2124	7.0	30	3.8	5.8	15	113
S1666-2	Y2125	2.1	13	5.5	5.5	8.0	23
S1667-2	Y2126	3.0	25	8.0	8.8	13	110
S1670-2	Y2130	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
S1670MS-2	Y2130 spike	<0.1	<0.1	<0.1	<0.1	110	98
S1663MB-2	----	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1

TABLE II

Quality Assurance

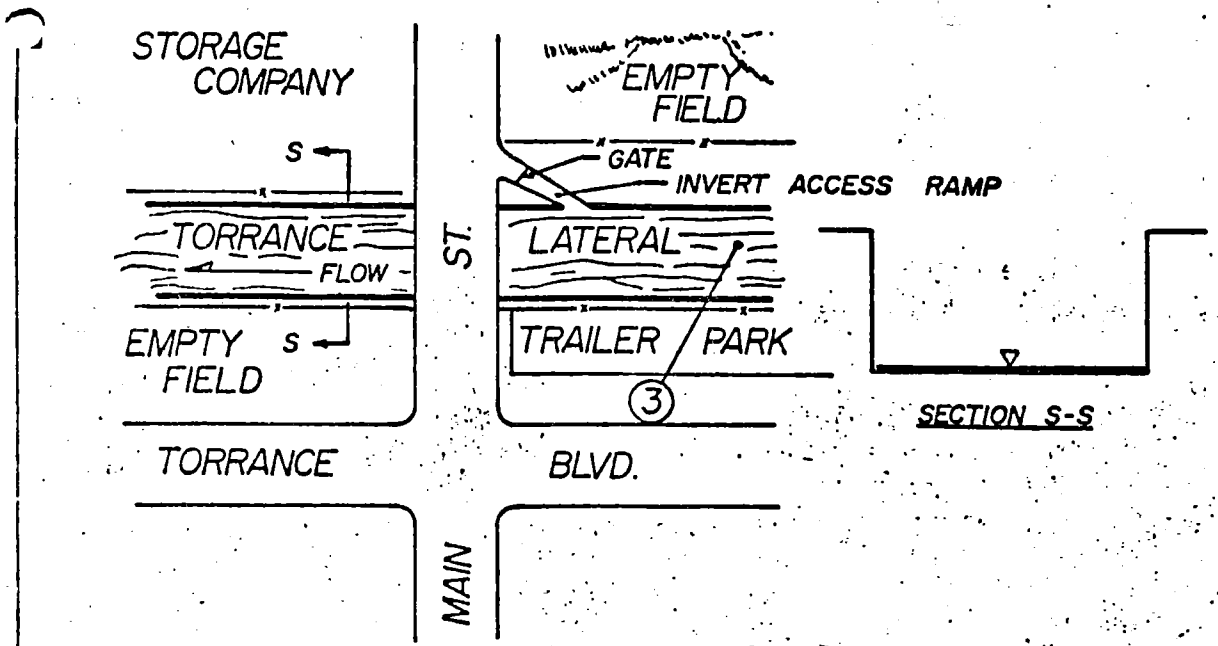
A. Spiked Sample

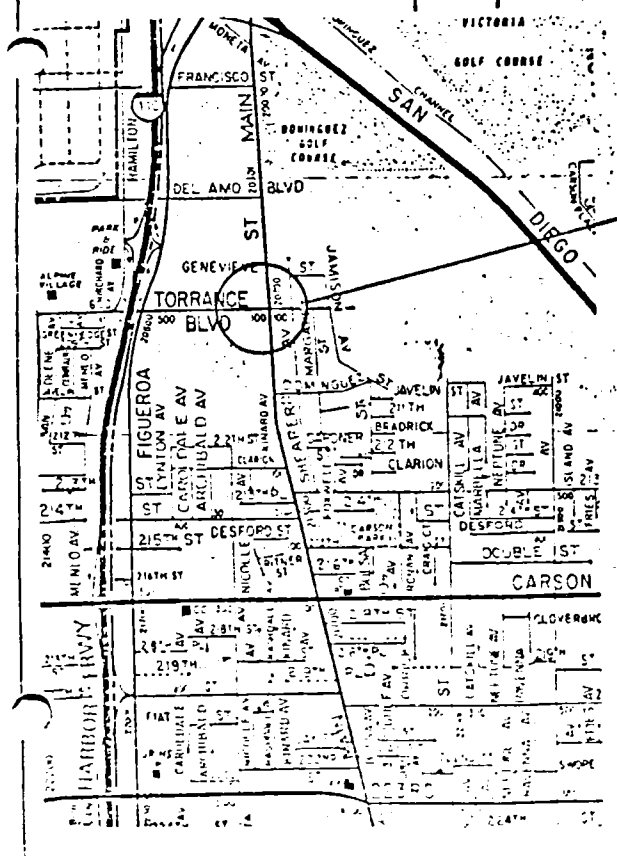
		o,p-DDT			p,p-DDT		
CAL I.D.	EPA I.D.	added	found	%	added	found	%
S1670-2	Y2130	0	<0.1	-	0	<0.1	-
S1670MS-2	Y2130 spike	100	110	110	100	98	98

B. Duplicate Sample

Refer to Table I for S1663-2 and S1663D-2 data.

APPENDIX A

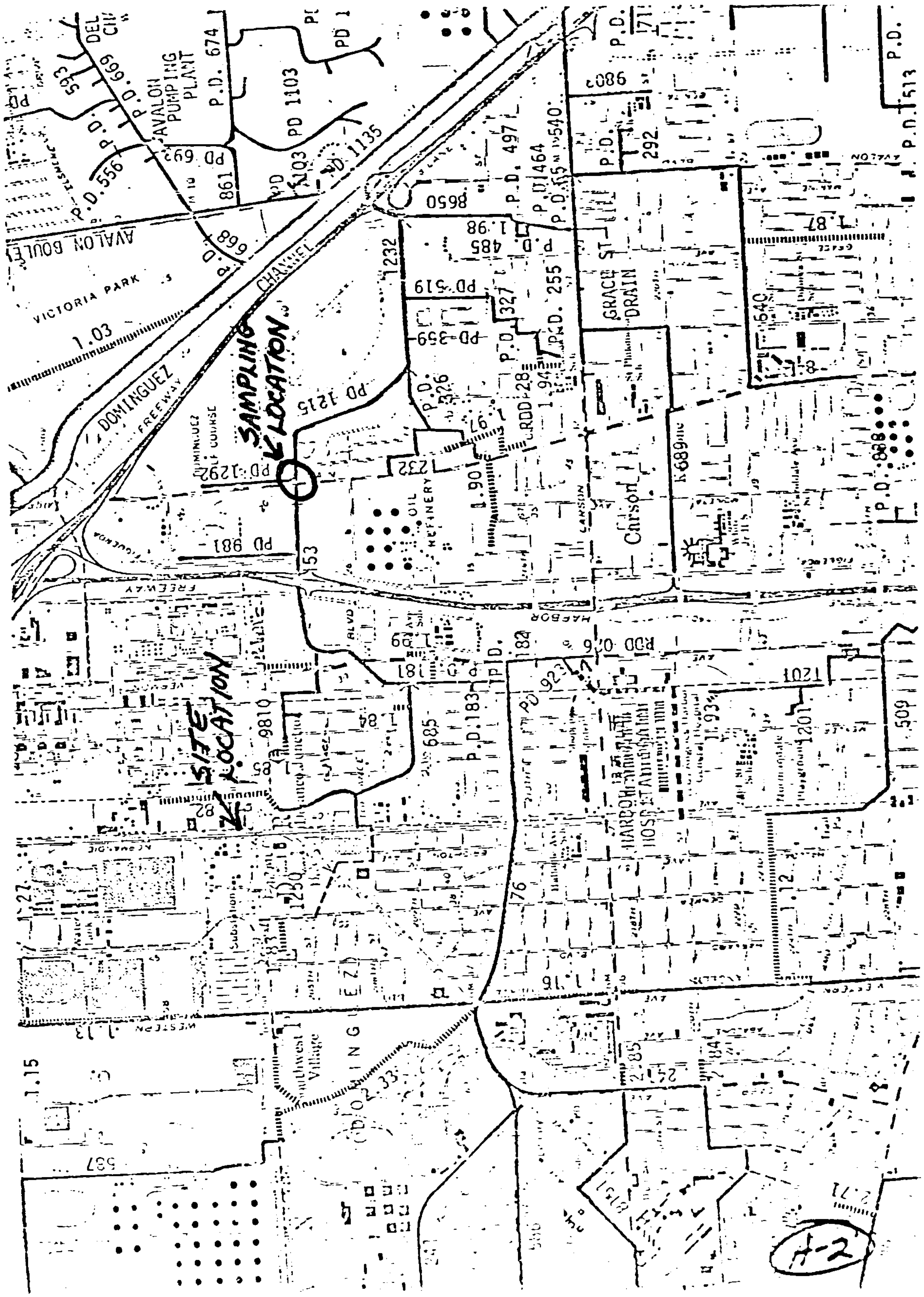


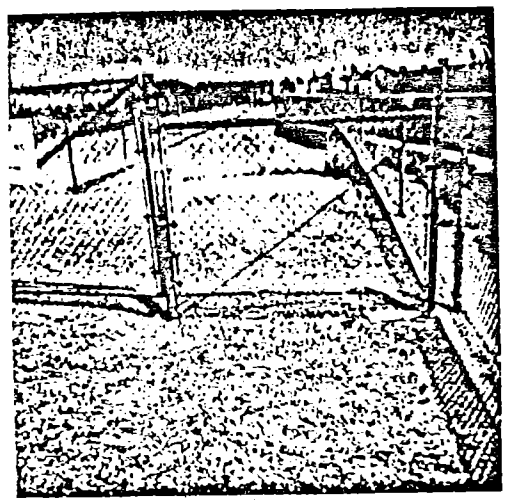


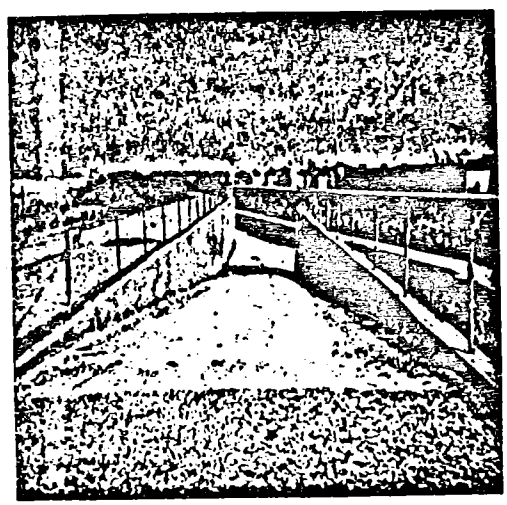
3 TORRANCE LATERAL AT MAIN ST. (S.D. 1153)
GAGING STATION NO.
T.G. 69-A3

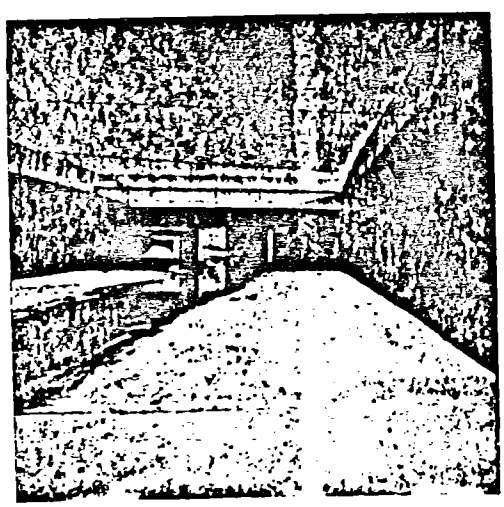
N

PREPARED M.B.	LOS ANGELES COUNTY FLOOD CONTROL DISTRICT
DATE 6/11/82	WATER QUALITY MONITOR I SAMPLING LOCATION A-1
SCALE NONE	


SAMPLING LOCATION
SITE LOCATION
DOMINGUEZ CHANNEL
DOMINGUEZ FREEWAY
VICTORIA PARK
AVALON PUMPING PLANT
AVALON BOULE
OIL REFINERY
GRACE ST DRAIN
HARBOR
A-2







Torrance Laterial at Main Street (S.D. 1173)
Drive down access ramp, sample at point of greatest water movement.

T.G. 69-A3 Harbor Fwy. south exit on Torrance Blvd.-east to Main St. north.

A-3

SUMMARY

**** STORET SUMMARY SECTION ****

FOLLOWING IS A RETRIEVAL OF DATA FROM THE ENVIRONMENTAL PROTECTION AGENCY'S STORET SYSTEM, A DATABASE OF SAMPLING SITES AND THEIR ASSOCIATED QUALITY DATA. THE INFORMATION WAS RETRIEVED USING SPECIFIC STORET INSTRUCTION SETS IN COMBINATION TO SELECT ONLY THE DATA REQUESTED FOR THIS RETRIEVAL. BRIEF EXPLANATIONS OF THE INSTRUCTION SETS ARE INCLUDED BELOW. QUESTIONS MAY BE DIRECTED TO THE STORET USER ASSISTANCE SECTION AT (202) 382-7220 OR (800) 424-9067.

****

FOLLOWING IS THE FORMAT FOR THE STATION HEADER INFORMATION WHICH APPEARS ON EACH PAGE OF THE RETRIEVAL UNLESS STATION AGGREGATION WAS PERFORMED

```
                                    STATION NUMBER(S)
                                    LATITUDE/LONGITUDE PRECISION CODE
                                    STATION LOCATION
                                    STATE/COUNTY CODE STATE NAME COUNTY NAME
                                    MAJOR BASIN NAME MAJ/MIN/SUB BASIN CODE
                                    MINOR BASIN NAME
                                    AGENCY CODE     HYDROLOGIC UNIT CODES
*STATION TYPE
*LOCATION VERIFIED BY/DATE   STA. DEPTH   STA. STORED DATE   ARCHIVE CLASS   CSN-RSP*
*
*RIVER MILE INDEX
```

CONTINUED ON NEXT PAGE(S)

A-4

1977-1982 ACTUAL SAMPLE VALUES

RETRIEVAL PROGRAM •

PGM=RET
THIS IS A TABULAR LISTING OF ACTUAL SAMPLE VALUES FOR SELECTED PARAMETERS

NO BEGINNING DATE WAS REQUESTED -- STORET ASSUMED THE BEGINNING DATE WAS THAT OF THE OLDEST DATA VALUE FOUND
NO ENDING DATE WAS REQUESTED -- STORET ASSUMED THE ENDING DATE WAS THAT OF THE MOST RECENT DATA VALUE FOUND

STATION SELECTION WAS BY:

AGENCY CODE(S) AND STATION NUMBER(S) FOR THE FOLLOWING AGENCY(S):
21CALAFD

DATA SPECIFICATIONS:

REQUESTED PARAMETERS:
PARAMETER CODES AND ABBREVIATIONS

39360	DDD	WHL SMPL UG/L	39365	DDE	WHL SMPL UG/L	39370	DDT	WHL SMPL UG/L
39300	P,P'DDT	TOT UG/L	39305	O,P' DDT	WHL SMPL UG/L	39310	P,P'DDD	TOT UG/L
39315	O,P' DDD	WHL SMPL UG/L	39320	P,P'DDE	TOT UG/L	39327	O P DDE	WHL SMP L UG/L

NOTE
NO REMARK CODE RESTRICTIONS WERE SPECIFIED - COMPUTATIONS WILL BE PERFORMED WITHOUT REGARD TO DATA REMARKS

DATA RESTRICTIONS:

NOTE
NO DEPTH INDICATOR RESTRICTIONS WERE SPECIFIED - COMPUTATIONS WILL BE PERFORMED WITHOUT REGARD TO DEPTH INDICATORS

NOTE
NO GRAB/COMPOSITE RESTRICTIONS WERE SPECIFIED, SO BOTH GRAB AND COMPOSITE SAMPLE TYPES MAY HAVE BEEN INCLUDED - COMPUTATIONS WILL BE PERFORMED WITHOUT REGARD TO SAMPLE TYPE

NOTE
NO COMPOSITE SAMPLE RESTRICTIONS WERE SPECIFIED - COMPUTATIONS WILL INCLUDE STATISTICAL FEATURES OF THE COMPOSITING PROCESS, PRODUCING VALID RESULTS ONLY WHEN SOPHISTICATED COMPOSITES ARE NOT ENCOUNTERED. SPECIFY COMPOSITE HANDLING KEYWORDS "ANC" AND/OR "DSROC" IF NEEDED

***** END OF SUMMARY SECTION *****

A-5

STORET RETRIEVAL DATE 83/01/13

TORMAI Z6320050 TG 69A3J1 1
33 50 19.0 118 16 45.0 2
TORRANCE LATERAL @ MAIN AVENUE
06037 CALIFORNIA
DOMINGUEZ CHANNEL 1406
TORRANCE QUADRANGLE
21CALAFD 770923
0999 FEET DEPTH CLASS 00 CSN-RSP 0308240-0402742

/TYPA/AMBNT/STREAM

DATE FROM TO	TIME OF DAY	DEPTH FEET	39360 DDD WHL SMPL UG/L	39365 DDE WHL SMPL UG/L	39370 DDT WHL SMPL UG/L	39300 P,P'DDT TOT UG/L	39305 O,P' DDT WHL SMPL UG/L	39310 P,P'DDD TOT UG/L	39315 O,P' DDD WHL SMPL UG/L	39320 P,P'DDE TOT UG/L	39327 O P DDE WHL SMP L UG/L
77/10/03	07 10	0000	0.070K	0.120	0.230						
77/11/01	09 25	0000	0.020K	0.030K	0.130K						
77/12/07		0000	0.020K	0.080K	0.310						
77/12/27	10 00	0020	0.020K	0.370							
78/01/05	06 40	0000	0.270K	0.410							
78/01/10	07 30	0020	0.100K	0.440							
78/01/16	20 45	0020	0.090	0.370	0.860						
78/02/03	07 15	0000	0.020K	0.120	0.370						
78/02/07	19 50	0020	0.020K	0.400	0.790						
78/02/28	21 00	0020	0.020K	0.260	0.540						
78/03/04	12 50	0020	0.020K	0.510							
78/04/04	06 50	0000	0.020K	0.020K	0.180						
78/05/03	07 45	0020	0.020K	0.020K	0.020K						
78/06/01	07 00	0000	0.020K	0.020K	0.020K						
78/07/07	06 45	0000	0.030K	0.170	0.200						
78/08/07	06 45	0000	0.020K	0.020K	0.020K						
78/09/06	06 30	0020	0.270	0.020	0.160K						
78/10/05	06 30	0000	0.020K	0.020K	0.110						
78/11/03	05 50	0000	0.020K	0.050	0.450						
78/11/21	19 50	0020	0.020	0.260	0.610						
78/12/04	06 20	0000	0.020	0.030	0.140						
78/12/18	12 55	0020	0.070K	0.490							
79/01/04	06 35	0000	0.090	0.420K	0.020						
79/01/15	13 40	0020	0.020K	0.190K	0.200						
79/02/02	06 30	0020	0.210	0.270K	0.800						
79/03/05	06 00	0000	0.020K	0.030	0.190						
79/03/27	14 00	0020	0.060	0.450							
79/04/03	07 00	0000	0.020K	0.020K	0.020K						
79/05/02	06 15	0000	0.020K	0.020K	0.020K						
79/06/07	08 05	0000	0.020	0.020K	0.030K						
79/07/05	07 50	0000	0.020K	0.020K	0.050						
79/08/06	06 40	0000	0.030	0.020K	0.020						
79/09/05	10 00	0000	0.020	0.020K	0.020K						
79/10/04	06 30	0000	0.010K	0.010K	0.010K						
79/11/02	05 50	0000	0.010K	0.010K	0.034						
79/12/03	06 10	0000	0.020K	0.020K	0.140K	0.134	0.010K	0.010K	0.010K	0.010K	0.010K

A-6

STORET RETRIEVAL DATE 83/01/13

TORMAI Z6320050 TG 69A3J1 1
33 50 19.0 118 16 45.0 2
TORRANCE LATERAL @ MAIN AVENUE
06037 CALIFORNIA
DOMINGUEZ CHANNEL 1406
TORRANCE QUADRANGLE
21CALAFD 770923
0999 FEET DEPTH CLASS 00 CSN-RSP 0308240-0402742

/TYPA/AMBNI/STREAM

DATE FROM TO	TIME OF DAY	DEPTH FEET	39360 DDD WHL SMPL UG/L	39365 DDE WHL SMPL UG/L	39370 DDT WHL SMPL UG/L	39300 P,P'DDT TOT UG/L	39305 O,P' DDT WHL SMPL UG/L	39310 P,P'DDD TOT UG/L	39315 O,P' DDD WHL SMPL UG/L	39320 P,P'DDE TOT UG/L	39327 O P DDE WHL SMP L UG/L
80/01/08	05 53	0000	0.784	0.434	0.223	0.010K	0.223	0.688	0.096	0.310	0.124
80/01/09	11 50	0020		0.550	0.480	0.045	0.448	1.270	0.112	0.365	0.194
80/02/06	06 00	0000	0.040K	0.050	0.130	0.106	0.031	0.010K	0.031	0.014	0.042
80/02/15	16 05	0020	0.200	0.490		1.320	0.877	0.133	0.072	0.344	0.153
80/02/20	05 55	0020	0.020K	0.110	0.530	0.385	0.153	0.010K	0.010K	0.080	0.039
80/03/06	06 10	0020	0.020K	0.040	0.080	0.236	0.060	0.010K	0.011	0.027	0.028
80/04/04	09 45	0000	0.020K	0.050	0.290	0.226	0.077	0.010K	0.010K	0.032	0.020
80/05/06	05 50	0000	0.020K	0.030K	0.300	0.248	0.102	0.010K	0.010K	0.023	0.010K
80/06/04	06 30	0000	0.010K	0.020	0.270	0.230	0.040	0.010K	0.010K	0.020	0.010K
80/07/10	06 10	0000	0.050	0.040	0.090	0.090	0.010K	0.050	0.010K	0.020	0.020
80/08/06	05 55	0000	0.010K	0.010K	0.010K	0.010K	0.010K	0.010K	0.010K	0.010K	0.010K
80/09/03	06 15	0000	0.040	0.120	0.010K	0.010K	0.010K	0.040	0.010K	0.040	0.080
80/10/02	06 15	0000				0.080	0.010	0.030	0.020	0.020	0.010K
80/11/07	06 15	0000	0.010	0.120	0.100	0.100	0.010K	0.010	0.010K	0.120	0.010K
80/12/02	08 40	0000	0.010K	0.010K	0.020	0.020	0.010K	0.010K	0.010K	0.010K	0.010K
80/12/04	11 25	0020	0.560			9.720	3.190	0.010K	0.560	4.520	0.610
81/01/06	08 55	0000	0.010K	7.470	4.070	4.080	0.010K	0.010K	0.010K	0.010K	7.480
81/01/28	10 20	0020	4.100	3.160	39.200	35.200	3.970	2.720	1.380	3.150	0.460
81/02/04	08 30	0000	0.090	0.090	0.400						0.010
81/03/02	12 14	0020	1.470	1.550	18.700	16.000	2.650	0.990	0.480	1.350	0.200
81/03/10	08 45	0000	0.350	0.300	1.390	1.080	0.310	0.150	0.200	0.230	0.070
81/05/05	09 10	0000	0.040	0.120	0.400	0.310	0.090	0.040	0.010K	0.080	0.040
81/07/09	08 55	0000	0.030	0.090	0.100	0.080	0.020	0.010K	0.030	0.030	0.060
81/08/12	09 05	0000	0.230	0.130	0.180	0.120	0.060	0.080	0.150	0.060	0.070
81/09/01	09 05	0000	0.090	0.060	0.090	0.070	0.020	0.060	0.030	0.040	0.020
81/10/07	09 05	0000	1.870	1.740	0.010K	0.010K	0.010K	1.870	0.010K	0.010K	1.740
81/11/05	09 10	0000	0.110	0.140	0.400	0.330	0.070	0.070	0.040	0.100	0.040
81/12/04	08 40	0000	0.040	0.110	0.110	0.080	0.030	0.030	0.010	0.070	0.040
82/01/05	10 05	0020	0.330	0.600	1.650	1.360	0.290	0.250	0.080	0.460	0.140
82/02/03	09 20	0000									0.010K
		0000	0.010K	0.010K	0.010K	0.010K	0.010K	0.010K	0.010K	0.010K	
82/03/02	11 00	0020	0.440	1.890	5.550	2.390	3.160	0.370	0.070	1.710	0.180
82/03/04	09 20	0000				0.290	0.080	0.060	0.010K	0.070	0.030
		0000	0.060	0.100	0.370						
82/03/17		0020	0.430	0.820	8.310	7.510	0.800	0.330	0.100	0.610	0.210
82/04/15	09 10	0000	0.670	3.550	2.760	1.780	0.980	0.470	0.200	2.810	0.740

A-7

STORET RETRIEVAL DATE 83/01/13

TORMAI Z6320050 TG 69A3J1 1
33 50 19.0 118 16 45.0 2
TORRANCE LATERAL @ MAIN AVENUE
06037 CALIFORNIA
DOMINGUEZ CHANNEL 1406
TORRANCE QUADRANGLE
21CALAFD 770923
0999 FEET DEPTH CLASS 00 CSN-RSP 0308240-0402742

/TYPA/AMNT/STRAM

DATE FROM TO	TIME OF DAY	DEPTH FEET	39360 DDD WHL SMPL UG/L	39365 DDE WHL SMPL UG/L	39370 DDT WHL SMPL UG/L	39300 P,P'DDT TOT UG/L	39305 O,P' DDT WHL SMPL UG/L	39310 P,P'DDD TOT UG/L	39315 O,P' DDD WHL SMPL UG/L	39320 P,P'DDE TOT UG/L	39327 O P DDE WHL SMP L UG/L
82/08/15	09 25	0000	0.200	0.450	0.570	0.470	0.100	0.150	0.050	0.400	0.050
82/08/11	09 25	0000	0.030	0.060	0.070	0.050	0.020	0.030	0.010K	0.040	0.020
82/09/16	09 50	0000	0.080	0.080	0.140	0.110	0.030	0.070	0.010	0.050	0.030
82/10/12	09 20	0000	0.010K	0.630	0.010K	0.010K	0.010K	0.010K	0.010K	0.010K	0.630
82/11/02	09 30	0000	0.010K	0.010K	0.020	0.020	0.010K	0.010K	0.010K	0.010K	0.010K

A-8

SUMMARY

**** STORET SUMMARY SECTION ****

FOLLOWING IS A RETRIEVAL OF DATA FROM THE ENVIRONMENTAL PROTECTION AGENCY'S STORET SYSTEM, A DATABASE OF SAMPLING SITES AND THEIR ASSOCIATED QUALITY DATA. THE INFORMATION WAS RETRIEVED USING SPECIFIC STORET INSTRUCTION SETS IN COMBINATION TO SELECT ONLY THE DATA REQUESTED FOR THIS RETRIEVAL. BRIEF EXPLANATIONS OF THE INSTRUCTION SETS ARE INCLUDED BELOW. QUESTIONS MAY BE DIRECTED TO THE STORET USER ASSISTANCE SECTION AT (202) 382-7220 OR (800) 424-9067.

****

FOLLOWING IS THE FORMAT FOR THE STATION HEADER INFORMATION WHICH APPEARS ON EACH PAGE OF THE RETRIEVAL UNLESS STATION AGGREGATION WAS PERFORMED

STATION NUMBER(S)
LATITUDE/LONGITUDE PRECISION CODE
STATION LOCATION
STATE/COUNTY CODE STATE NAME COUNTY NAME
MAJOR BASIN NAME MAJ/MIN/SUB BASIN CODE
MINOR BASIN NAME
AGENCY CODE HYDROLOGIC UNIT CODES
*STATION TYPE
LOCATION VERIFIED BY/DATE STA. DEPTH STA. STORED DATE ARCHIVE CLASS CSN-RSP
*RIVER MILE INDEX

CONTINUED ON NEXT PAGE(S)

A9

1977-1982 DRY WEATHER STATISTICAL SUMMARY

1641

RETRIEVAL PROGRAM

RQSELIVE01
THIS IS AN INVENTORY RETRIEVAL SHOWING SUMMARY STATISTICS FOR SELECTED PARAMETERS

NO BEGINNING DATE WAS REQUESTED -- STORET ASSUMED THE BEGINNING DATE WAS THAT OF THE OLDEST DATA VALUE FOUND
NO ENDING DATE WAS REQUESTED -- STORET ASSUMED THE ENDING DATE WAS THAT OF THE MOST RECENT DATA VALUE FOUND

STATION SELECTION WAS BY:

AGENCY CODE(S) AND STATION NUMBER(S) FOR THE FOLLOWING AGENCY(S):
21CALED

DATA SPECIFICATIONS:

REQUESTED PARAMETERS:
PARAMETER CODES AND ABBREVIATIONS

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39300	P,P'DDE	TOT UG/L	30305	INVALID PARAMETER CODE		39310	P,P'DDD	TOT UG/L
39315	O,P' DDD WHL SMPL UG/L		39320	P,P'DDE	TOT UG/L	39327	O P DDE	WHL SMP L UG/L

NOTE
NO REMARK CODE RESTRICTIONS WERE SPECIFIED - COMPUTATIONS WILL BE PERFORMED WITHOUT REGARD TO DATA REMARKS

DATA RESTRICTIONS:

A UPPER DEPTH OF 10 FEET

NOTE
NO GRAB/COMPOSITE RESTRICTIONS WERE SPECIFIED, SO BOTH GRAB AND COMPOSITE SAMPLE TYPES MAY HAVE BEEN INCLUDED - COMPUTATIONS WILL BE PERFORMED WITHOUT REGARD TO SAMPLE TYPE

NOTE
NO COMPOSITE SAMPLE RESTRICTIONS WERE SPECIFIED - COMPUTATIONS WILL INCLUDE STATISTICAL FEATURES OF THE COMPOSITING PROCESS, PRODUCING VALID RESULTS ONLY WHEN SOPHISTICATED COMPOSITES ARE NOT ENCOUNTERED. SPECIFY COMPOSITE HANDLING KEYWORDS "ANC" AND/OR "DSROC" IF NEEDED

***** END OF SUMMARY SECTION *****

A-10

STORET RETRIEVAL DATE 83/01/18 - INVENT - VERSION OF SEP. 1981

FORMAT Z6320050 TG 69A3J1 1
33 50 19.0 118 16 45.0 2
TORRANCE LATERAL @ MAIN AVENUE
06037 CALIFORNIA
DOMINGUEZ CHANNEL 1406
TORRANCE QUADRANGLE
21CALAFD 770923
0999 CLASS 00 CSN-RSP 0308240-0402742

/11YNA/ALMOI/STORAN

PARAMETER			RMK	NUMBER	MEAN	VARIANCE	STAN DEV	COEF VAR	STAND ER	MAXIMUM	MINIMUM	BEG DATE	END DATE
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			TOT	29	.350483	.649859	.806138	2.30008	.149696	4.08000	.010000	79/12/03	82/11/02
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			K	12	.010000	.634E-10	.000008	.000797	.000002	.010000	.010000	79/12/03	82/11/02
			TOT	29	.138552	.132591	.364130	2.62812	.067617	1.87000	.010000	79/12/03	82/11/
39315 O,P' DDD	WHL SMPL	UG/L		12	.072250	.005140	.071691	.992268	.020696	.200000	.010000	80/01/08	82/09/1
			K	17	.010000	.436E-10	.000007	.000661	.000002	.010000	.010000	79/12/03	82/11/02
			TOT	29	.035759	.002993	.054705	1.52985	.010159	.200000	.010000	79/12/03	82/11/02
39320 P,P'DDE		TOT UG/L		21	.218047	.363100	.602578	2.76352	.131493	2.81000	.014000	80/01/08	82/09/16
			K	8	.010000	.665E-10	.000008	.000816	.000003	.010000	.010000	79/12/03	82/11/02
			TOT	29	.160655	.268312	.517989	3.22423	.096188	2.81000	.010000	79/12/03	82/11/02
39327 O,P DDE	WHL SMP	L UG/L		21	.540762	2.69146	1.64057	3.03381	.358001	7.48000	.010000	80/01/08	82/10/12
			K	9	.010000	.582E-10	.000008	.000763	.000003	.010000	.010000	79/12/03	82/11/02
			TOT	30	.381533	1.91738	1.38469	3.62929	.252809	7.48000	.010000	79/12/03	82/11/02
39360 DDD	WHL SMPL	UG/L		23	.215391	.171205	.413759	1.92101	.086277	1.87000	.010000	78/12/04	82/09/16
			K	28	.028571	.002383	.048816	1.70857	.009225	.270000	.010000	77/10/03	82/11/02
			TOT	51	.112823	.085431	.292286	2.59065	.040928	1.87000	.010000	77/10/03	82/11/02
39365 DDE	WHL SMPL	UG/L		30	.562799	2.17845	1.47596	2.62253	.269472	7.47000	.020000	77/10/03	82/10/12
			K	21	.040000	.007800	.088317	2.20794	.019272	.420000	.010000	77/11/01	82/11/02
			TOT	51	.347528	1.33415	1.15505	3.32362	.161740	7.47000	.010000	77/10/03	82/11/02
39370 DDT	WHL SMPL	UG/L		36	.411027	.629342	.793311	1.93007	.132218	4.07000	.020000	77/10/03	82/11/02
			K	14	.032857	.001914	.043753	1.33160	.011693	.140000	.010000	77/11/01	82/10/12
			TOT	50	.305140	.479457	.692429	2.26922	.097924	4.07000	.010000	77/10/03	82/11/02

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00000030 S=IOP-AI,
00000040 P=39340,P=39365,P=39370,P=39300,P=30305,P=39310,
00000050 P=39314,P=39320,P=39327,
00000060 LL=10,
00000061 ./EPAWEL    JOB (AB16STORPUUU,MWEL),STORET,NOTIFY=EPAWEL,TIME=5,
00000062 ./               MSGLEVEL=(1,1),PRTY=1
00000063 **ROUTE  PRINT RMT75
00000064 **JOBPARM LINES=10
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SUMMARY

**** STORET SUMMARY SECTION ****

FOLLOWING IS A RETRIEVAL OF DATA FROM THE ENVIRONMENTAL PROTECTION AGENCY'S STORET SYSTEM, A DATABASE OF SAMPLING SITES AND THEIR ASSOCIATED QUALITY DATA. THE INFORMATION WAS RETRIEVED USING SPECIFIC STORET INSTRUCTION SETS IN COMBINATION TO SELECT ONLY THE DATA REQUESTED FOR THIS RETRIEVAL. BRIEF EXPLANATIONS OF THE INSTRUCTION SETS ARE INCLUDED BELOW. QUESTIONS MAY BE DIRECTED TO THE STORET USER ASSISTANCE SECTION AT (202) 382-7220 OR (800) 424-9067.

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STATION NUMBER(S)
LATITUDE/LONGITUDE PRECISION CODE
STATION LOCATION
STATE/COUNTY CODE STATE NAME COUNTY NAME
MAJOR BASIN NAME MAJ/MIN/SUB BASIN CODE
MINOR BASIN NAME
AGENCY CODE HYDROLOGIC UNIT CODES
STATION TYPE
LOCATION VERIFIED BY/DATE STA. DEPTH STA. STORED DATE ARCHIVE CLASS CSN-HSP
RIVER MILE INDEX

CONTINUED ON NEXT PAGE(S)

A-13

1977-1982 WET WEATHER STATISTICAL SUMMARY

RETRIEVAL PROCESS

THIS IS A STORET RETRIEVAL SHOWING SUMMARY STATISTICS FOR SELECTED PARAMETERS

BEGIN DATE WAS REQUESTED -- STORET ASSUMED THE BEGINNING DATE WAS THAT OF THE OLDEST DATA VALUE FOUND
ENDING DATE WAS REQUESTED -- STORET ASSUMED THE ENDING DATE WAS THAT OF THE MOST RECENT DATA VALUE FOUND

STATION SELECTION WAS BY:

STATION(S) AND STATION NUMBER(S) FOR THE FOLLOWING AGENCY(S):
"EPAGRP"

DATA SPECIFICATIONS:

RETRIEVED PARAMETERS:
PARAMETER CODES AND ABBREVIATIONS

39365	DDE	WHL SMPL UG/L	39370	DDT	WHL SMPL UG/L		
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39320	P,P'DDE	TOT UG/L	39327	O,P DDE	WHL SMP	L UG/L	

** NOTE **
NO SAMPLE TYPE RESTRICTIONS WERE SPECIFIED - COMPUTATIONS WILL
BE PERFORMED WITHOUT REGARD TO DATA REMARKS

DATA RESTRICTIONS:

ALL DEPTH LEVELS OF 10 FEET
OR LESS WITHIN THE RANGE OF 30 FEET

** NOTE **
NO GRAB/COMPOSITE RESTRICTIONS WERE SPECIFIED, SO BOTH GRAB AND COMPOSITE SAMPLE TYPES MAY HAVE
BEEN RETRIEVED - COMPUTATIONS WILL BE PERFORMED WITHOUT REGARD TO SAMPLE TYPE

** NOTE **
COMPOSITE SAMPLE RESTRICTIONS WERE SPECIFIED - COMPUTATIONS WILL INCLUDE STATISTICAL FEATURES OF
THE COMPOSITING PROCESS, PRODUCING VALID RESULTS ONLY WHEN SOPHISTICATED COMPOSITES ARE NOT ENCOUNTERED.
SPECIFY CO-POSITE HANDLING KEYWORDS "NAVC" AND/OR "NOSNOC" IF NEEDED

***** END OF SUMMARY SECTION *****

A-14

STORET RETRIEVAL DATE 83/01/18 - INVENT - VERSION OF SEP. 1981

TORRAI 26320050 TG 69A331 1
33 50 19.0 118 16 45.0 2
TORRANCE LATERAL @ MAIN AVENUE
06037 CALIFORNIA
DOMINGUEZ CHANNEL 1406
TORRANCE QUADRANGLE
21CALAFD 770923
0499 CLASS 00 CSN=HSP 0308240=0402742

PARM			RNK	NUMBER	MEAN	VARIANCE	STAN DEV	COEF VAR	STAND ER	MAXIMUM	MINIMUM	BEG DATE	END DATE
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			K	3	.010000	.000000	.000000		.000000	.010000	.010000	80/02/20	80/12/04
			TOT	10	.609300	.733913	.856687	1.40602	.270908	2.72000	.010000	80/01/09	82/03/17
[illegible]	[illegible]	UG/L		9	.418333	.196940	.443779	1.39407	.147926	1.38000	.011000	80/01/09	82/03/17
			K	1	.010000					.010000	.010000	80/02/20	80/02/20
			TOT	10	.247500	.184565	.429610	1.49430	.135855	1.38000	.010000	80/01/09	82/03/17
[illegible]		TOT UG/L		10	1.26160	2.22505	1.49166	1.18236	.471705	4.52000	.027000	80/01/09	82/03/17
[illegible]	[illegible]	UG/L		10	.221400	.032552	.180423	.814920	.057055	.610000	.028000	80/01/09	82/03/17
[illegible]	[illegible]	UG/L		12	.641666	1.30540	1.14276	1.67642	.329886	4.10000	.020000	78/01/16	82/03/17
			K	10	.033000	.000801	.028304	.857695	.008950	.100000	.020000	77/12/27	80/03/06
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[illegible]		UG/L		19	.672631	.578797	.760787	1.13106	.174537	3.16000	.020000	77/12/27	82/03/17
			K	3	.100000	.016300	.127671	.797946	.073711	.270000	.020000	78/05/03	79/02/02
			TOT	22	.602727	.530086	.728070	1.20796	.155225	3.16000	.020000	77/12/27	82/03/17
[illegible]		UG/L		14	5.59285	119.555	10.9341	1.95502	2.92227	39.2000	.080000	78/01/16	82/03/17
			K	2	.030000	.004800	.098995	1.09994	.070000	.160000	.020000	78/05/03	78/09/06
			TOT	16	4.90500	107.148	10.3512	2.11034	2.58760	39.2000	.020000	78/01/16	82/03/17

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                                                    P=39315,P=39320,P=39327,
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/*                    MSGLEVEL=(1,1),PRTY=1
**JOBPARM  LINES=10
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A-16

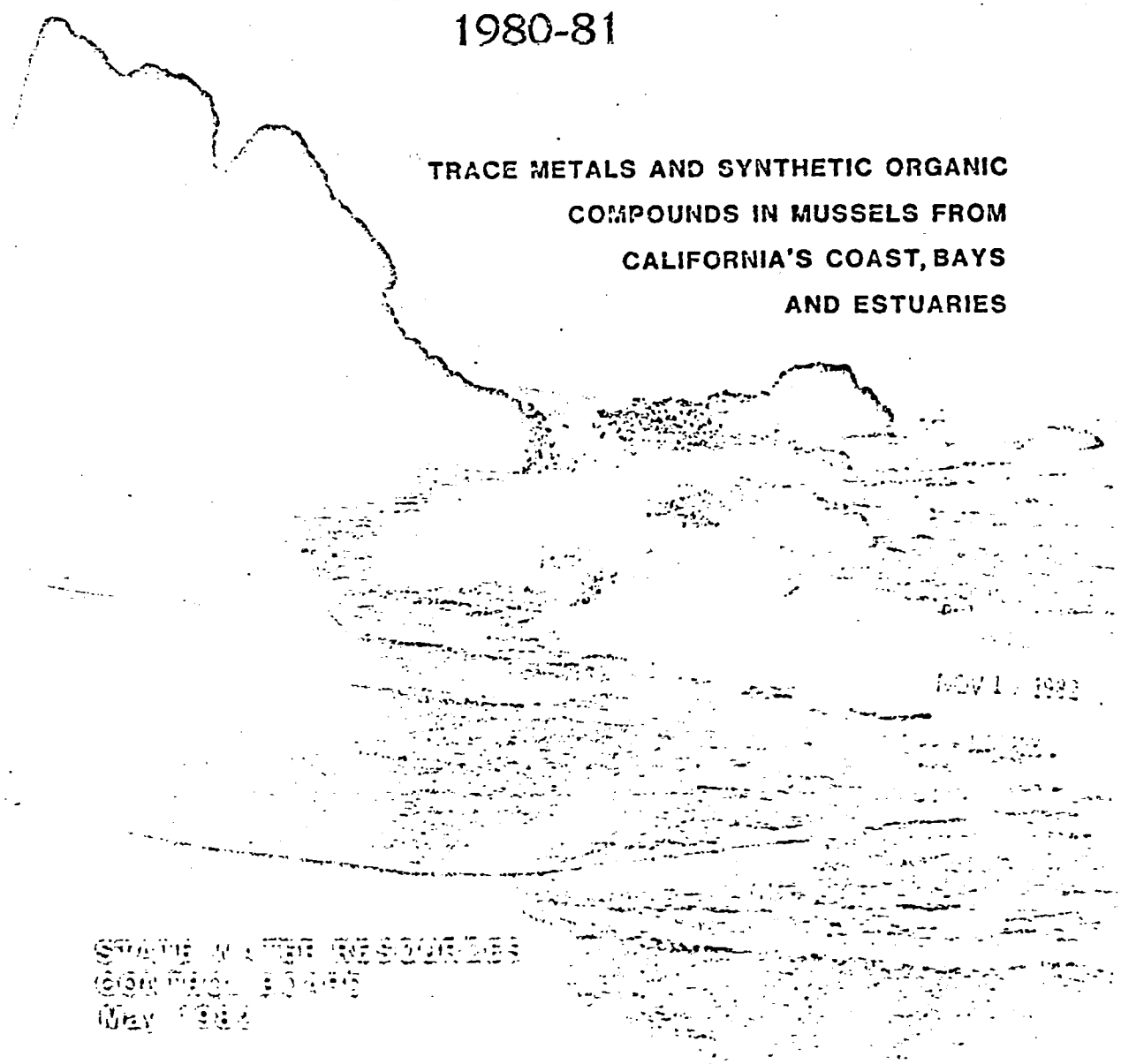
APPENDIX B

25472

...IFORNIA STATE MUSSEL WATCH

1980-81

TRACE METALS AND SYNTHETIC ORGANIC COMPOUNDS IN MUSSELS FROM CALIFORNIA'S COAST, BAYS AND ESTUARIES



B-1

CALIFORNIA MUSSEL WATCH: 1980-1981

PART III

SYNTHETIC ORGANIC COMPOUND IN MUSSELS, *M. CALIFORNIANUS* AND *M. EDULIS*, FROM CALIFORNIA'S COAST, BAYS AND ESTUARIES

by

Michael Martin[1]

David Crane[2]

Thomas Lew[2]

Warren Seto[2]

California Department of Fish and Game

Prepared for

State Water Resources Control Board

Division of Technical Services
Surveillance and Monitoring Unit

February 1982

[1]Marine Pollution Studies Laboratory, Monterey

[2]Fish and Wildlife Water Pollution Control Laboratory, Rancho Cordova

B-2

DDT Compounds

Coastal Resident Survey

The DDT compounds, expecially DDE, have had widespread effects in southern California upon such species as the Brown Pelican and the Double-Crested Cormorant (Risebrough et al., 1980). Word and Striplin (1980) postulated that DDT might have been the cause of major changes in the microcrustacean abundance at Whites Point, Palos Verdes Peninsula. Mearns (1981) reported that the discharge of DDT at Whites Point caused accumulation of DDT in sand dab, a flatfish, to levels above U.S. Food and Drug Administration limits for human consumption. Another indication of the accumulation of DDT in marine organisms was the discovery at the Los Angeles Zoo of acute DDT poisoning of three (3) species of fish-eating birds. The pesticide was found to have originated in contaminated feed, principally queenfish, collected off the Palos Verdes Peninsula (Clarke, 1978). Finally, Young et al. (1977) reported that despite major decreases of DDT emissions from the Los Angeles County Sanitation District outfall, only minor decreases were observed in DDT concentrations in bottom sediments and flatfish near the discharge. The principal source of DDT compounds to the Southern California Bight was found to be the discharge from this outfall at Whites Point. An industrial input of DDT compounds into the municipal system was terminated in 1970 and resulted in an approximately 94% decline in discharged amounts (Schaefer, 1980). Young and Heesen (1976) indicated that aerial fallout of DDT compounds was a major source into ocean waters of the Southern California Bight. Risebrough et al. (1980) postulated that this fallout might be the source of higher DDT levels

B-3

reported in the Los Angeles-Long Beach Harbor complex by both the National Mussel Watch (Goldberg et al., 1978) and State Mussel Watch (Martin et al., 1980)

In 1971 and 1974, the Southern California Coastal Water Research Project analyzed mussel tissues along the portions of California coast for DDT compounds. State Mussel Watch included some of these sites, as well as additional sites, in its annual DDT survey from 1977 through 1980. The analytical methodologies for DDT compounds are sufficiently similar to allow comparison of data in all of these previous surveys (see Risebrough et al., 1980; Martin et al., 1980).

In examining DDT metabolites in several species of fish and crustaceans from southern California waters, MacGregor (1974) found bioconcentration of DDT and, in addition, changes in the proportions of DDT related to its other metabolites, DDD and DDE, in the ocean for the years 1949 to 1972. Between 1949 and 1970, total DDT in fish and sediments increased off southern California. The major source of this insecticide apparently was the waste stream discharged to the Los Angeles County Sanitation District's wastewater treatment system by a major manufacturer of DDT (MacGregor, 1974). Following cessation of DDT discharge into the ocean off Los Angeles in 1970, a change occurred in the DDD:DDT ratio found in fish tissue. Prior to 1970, only eight of more than 500 specimens of a certain fish contained more DDD than DDT. MacGregor (1974) reported that five specimens of a deep sea fish species taken in April 1972 contained more DDD than DDT. It was his opinion that this shift in the DDD:DDT ratio was caused by the deposits in the industrial wastewater system that was cleaned for six months

B-4

between December 1970 and July 1971.

In 1980, mussels were analyzed for DDT compounds at 12 coastal stations and 3 bay stations to compare with previous surveys, and detect any spatial and temporal trends in concentration (Table 5, Figure 4). The Royal Palms station, historically the California station with the highest pp' DDE concentrations in mussels, again had the highest pp' DDE levels in comparison with other California stations this year. Mussels at Royal Palms remained at levels similar to those reported for 1979 (Martin et al., 1980). Mussels from Anaheim Bay also had relatively high pp' DDE levels in comparison with other California stations. The pattern shown by these data, along with the other southern California coastal stations, is that of greatly reduced rate of loss of DDT compounds in mussels in comparison with the rate of decline reported in the early 1970's. Thus, the termination of the discharge of DDT compounds and a general restriction in its use in the United States has not necessarily resulted in an immediate decline in DDT compounds in mussels to predischarge conditions.

The patterns of percent distribution of the three summed analogs of DDT in 1980 mussels at Royal Palms, Corona del Mar, and Oceanside (Table 6) were compared with MacGregor's (1974) earlier reports (Table 7) of DDT in southern California marine life. The order of abundance of the DDT analogs in mussels was identified to that pattern shown in earlier fish samples (MacGregor, 1974). The ranges of percentages of each analog from the 1980 mussels in comparison with the 1970-1971 pooled fish samples (MacGregor, 1974) were different: both mussel and fish tissues had approximately 70-90% of DDE, but differed in percentages of

B-5

TABLE 5. Concentrations of pp' DDE in *Mytilus* sp. in resident mussels along the California coast, selected bays, harbors, and islands between 1977 and 1980, expressed as ng/g on a dry weight basis.

Station	1977*	1978**	1979	1980
California mussels				
1 - Trinidad	8	5	7.6	13
2 - Pygmy Forest	15	6	11	18
3 - Bodega Head	16	9	41	25
4 - Duxbury Reef	--	--	9.8	8.6
5 - James V. Fitzgerald	175	7	8.8	14
7 - Pacific Grove	9	18	68	58
8 - J.P. Burns	31	12	26	27
9 - Santa Catalina Island Ben Weston	--	--	--	14
10 - Santa Catalina Island-Empire	--	--	--	28
11 - Royal Palms	1,100	275	1,900	1,300
14 - Corona del Mar	64	78	180	220
15 - Oceanside	45	66	136	390
Bay mussels				
6 - Elkhorn Slough	--	--	160	280
12 - Los Angeles-Long Beach Harbor	--	230	790	470
13 - Anaheim Bay	--	--	1,100	970

-- = No value reported.

* 1977 and 1978 values are from Risebrough et al., 1980.

** Mean value; N=2.

B-6

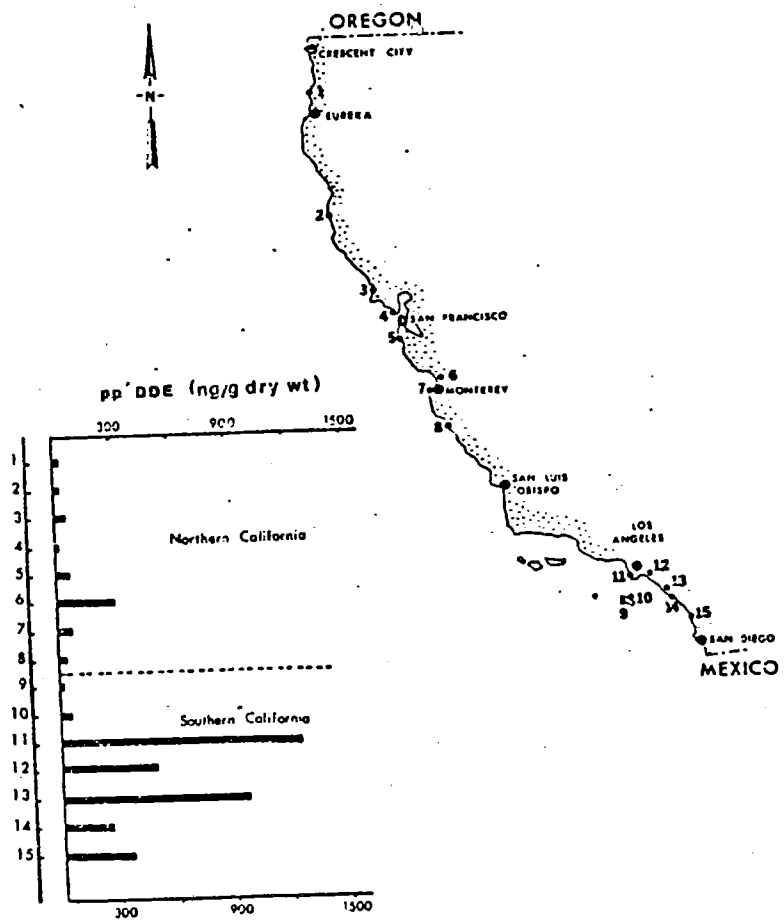


Figure 4. Concentrations of pp' DDE in 1980 resident mussel collections as ng/g dry weight.

B-7

TABLE 6. Percent distribution of pp' and op DDE, pp' and op DDD, and pp' and op DDT in mussel tissues from selected 1980 resident collections.

Location	Percent (%) as DDE (Σ of pp' and op)	DDD (Σ of pp' and op)	DDT (Σ pp' and op)
Royal Palms	87	12	1
Corona del Mar	77	14	9
Oceanside	65	20	15

B-8

DDD and DDT. In general, mussels had a higher percentage of DDD than did the 1970-1971 fish samples (MacGregor, 1974).

Bay Transplant Survey

Five areas of California were identified in the 1979 Mussel Watch Report (Martin et al., 1980) as having notably higher DDE residues in mussels: San Francisco Bay at Angel Island, Port Hueneme, Los Angeles-Long Beach Harbor, Anaheim Bay, and San Diego Bay at Shelter Island. The mussels at the San Francisco Bay-Angel Island station had a dramatically lower DDE value (71 ng/g) in 1980 (Table 8, Figure 8) in comparison with 1979 (Martin et al., 1980). In comparison with other 1979 San Francisco Bay stations, samples at Angel Island appeared to be quite different (Martin et al., 1980). In 1980, however, this station conformed to the pattern of the other stations in San Francisco Bay. Newport Harbor, on the other hand, showed substantial increase of DDE from 32 ng/g in 1979 to 880 ng/g in 1980. These two stations should be carefully examined in the following year's surveillance to determine if there are major changes occurring.

The pattern of pp' DDE (Figure 5) in mussels from the transplant stations was one of higher levels along the southern California bays and harbors in the vicinity of Los Angeles, and lower concentrations at offshore islands, as well as in central and northern California sites. San Francisco Bay stations showed generally higher levels of pp' DDE than nearby coastal sites.

Keith and Hunt (1966) reported DDT content for a variety of mammals, birds, and freshwater fishes of California. They stated that in warm-

B-9

TABLE 7. Summary of percent of pp' DDE, pp' DDD and pp' DDT in various marine animals from southern California waters in years 1970-1971 (from MacGregor, 1974).

	Percent as DDE	DDD	DDT
Fishes			
Leuroglossus stilbius	75.9	11.6	12.4
Melamostigma pammelas	87.9	2.7	9.4
Cyclothone acclinidens	80.7	4.7	14.6
Cyclothone acclinidens	76.1	6.9	17.0
Cyclothone acclinidens	83.2	5.9	0
Cyclothone acclinidens	89.5	4.5	6.0
Cyclothone acclinidens	84.9	8.5	6.6
range:	75.9-89.5	2.7-8.5	6.0-14.9
Crustaceans			
Gnathophausia gigas	76.7	7.2	16.1
Sergestes sp.	85.1	6.1	8.8
Sergestes sp.	82.9	6.1	11.0
Nematoscelis sp.	90.3	4.3	5.4
Nematoscelis sp.	90.2	3.0	4.9
range:	76.7-90.3	3.0-7.2	4.9-16.1

B-10

TABLE 8. Concentrations of pp' DDE in tissues of *Mytilus californianus* at selected California island, bay, and harbor transplant stations for 1979 and 1980, expressed as ng/g on a dry weight basis.

Station Number - Location	1979*	1980
1 - Humboldt Bay - North Samoa Bridge	40	6.3
2 - Humboldt Bay - South Samoa Bridge	12	4.8
3 - Humboldt Bay - Eureka Slough	17	11
4 - Bodega Harbor	38	2.1
5 - Tomales Bay	NA	19
6 - Bolinas Lagoon	8.1	21
7 - San Francisco Bay - Angel Island	1900	71
8 - San Francisco Bay - Treasure Island	72	69
9 - San Francisco Bay - Redwood City	NA	52
10 - San Francisco Bay - Dumbarton	NA	99
11 - Santa Cruz Harbor	49	55
12 - Elkhorn Slough Bridge	160	96
13 - Morro Bay - Virg's	NA	92
14 - Channel Island Marina	NA	290
15 - Port Hueneme	340	200
16 - Anacapa Island	NA	42
17 - Marina del Rey	NA	650
18 - Los Angeles - Long Beach Harbor	2000	1100
19 - Newport Harbor	32	880
20 - Mission Bay	NA	140
21 - San Diego Bay - Shelter Island	510	290
22 - San Diego Bay - G Street	NA	110
23 - San Diego Bay - Coronado Bridge	240	120

* From Martin et al., 1980
NA = not analyzed

B-11

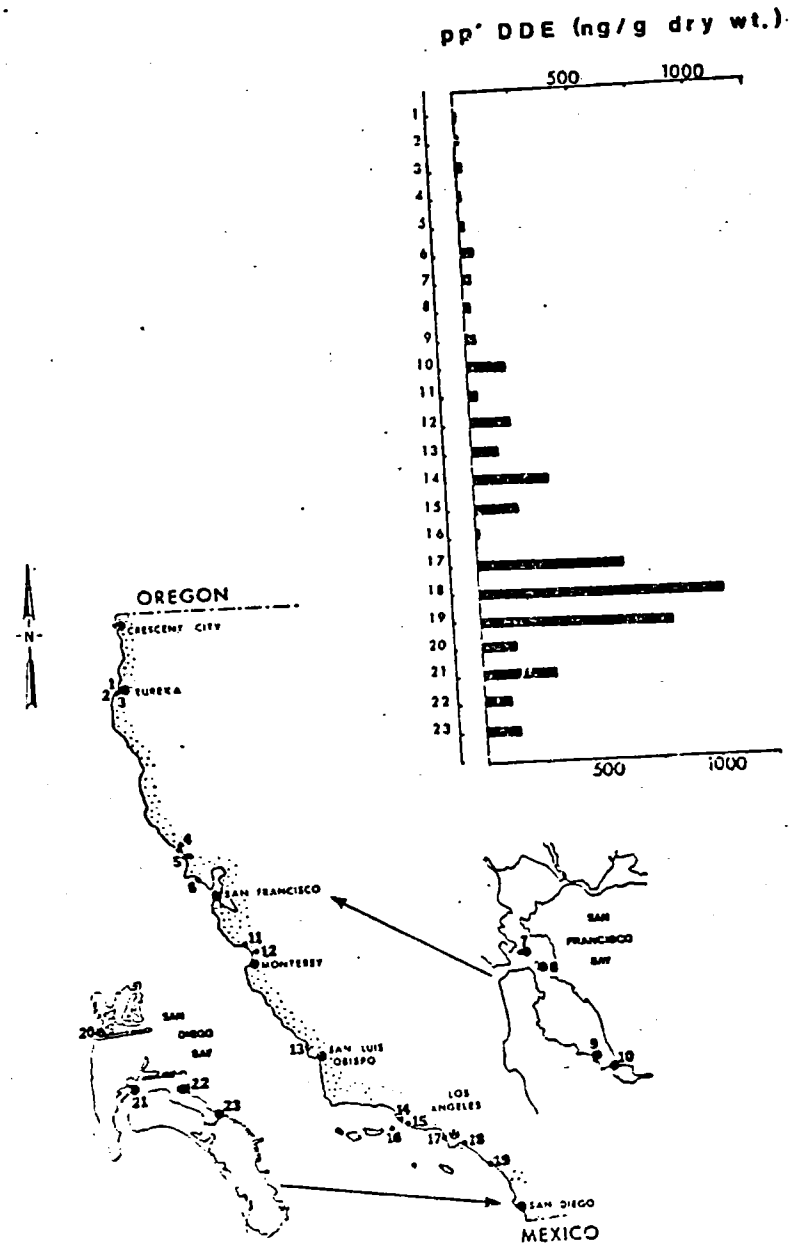


Figure 5. Concentrations of pp' DDE in California mussels at 1980 transplant stations expressed as ng/g dry weight.

B-12

water fish samples and in 3 species of fish-eating birds, DDD concentration in tissues were unusually high. It has further been noted that DDD was formerly used as an insecticide spray on some California lakes draining to the Central Valley (Hunt and Bischoff, 1960), but its use has been banned in the U.S. since 1972. De Lappe et al.(1980) stated that distributions of DDT compounds in mussels indicated that the Bay and Delta outflow are still a source of pp' DDT and, to a lesser extent, pp' DDD. In the 1980 Mussel Watch data, three of the four transplant samples in San Francisco Bay (Angel Island, Treasure Island, and Redwood City) had a higher percentage of DDD than did stations from other areas of California, such as those from the Los Angeles-Long Beach Harbor. The discrepancy between DDT's former use (manufacture) and long persistence requires further monitoring to track the trend of concentrations in biota.

PCB Comoounds

Coastal Resident Surveys

Polychlorinated biphenyls (PCB) have been identified in sediments and marine organisms in California coastal and estuarine ecosystems since 1967 (Young et al., 1977; Risebrough et al., 1968). During the past several years, amounts of PCB's discharged from the major submarine outfalls of the Southern California Bight have been reduced because of general use restrictions for PCB's. In southern California, the discharge of PCB's has decreased from 19 metric tons in 1972 to about 1.5 metric tons in 1979 (Schafer, 1980). Despite those reductions, the PCB levels in Dover sole had remained unchanged until 1974 (McDermott-Ehrlich et al., 1977). Young et al. (1977) reported a similar trend of reduction of PCB's in bottom sediments and Dover sole off Palos

B-13

Total chlordane levels in mussels from Fort Baker are approximately twice the values found at Duxbury Reef and James V. Fitzgerald (Table 6). The differences in values between stations in north, south and central bay are not great enough to allow identification of point sources.

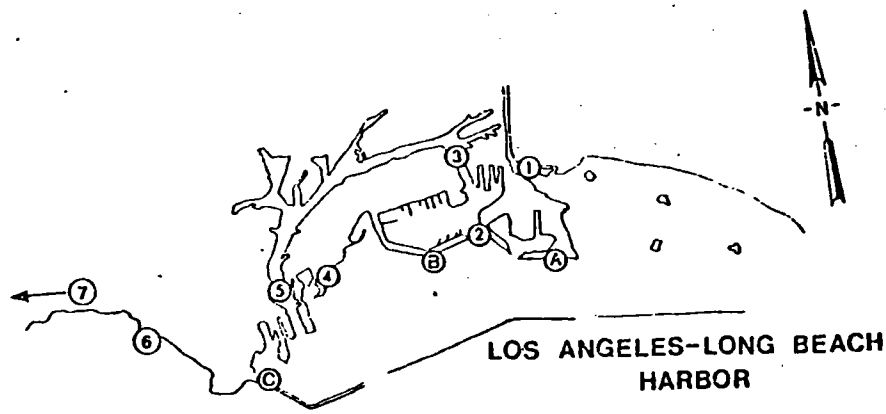
Dieldrin showed little spatial variation within San Francisco Bay. The San Mateo Bridge and Redwood City stations had mussels with higher dieldrin concentrations than mussels from Fort Baker, Richmond Bridge, and Point Pinole; however, the difference between the highest and lowest tissue concentrations at Bay stations was only a factor of 2.

Los Angeles-Long Beach Harbor

Mussels collected from Los Angeles-Long Beach Harbor contained PCB's and DDT in concentrations substantially greater than those at the reference sites. In southern California, it appears that DDT and PCB concentrations in mussels have stabilized, suggesting a recycling (Smokler et al., 1979) or a chronic input from surface runoff or aerial fallout (Young and Heeson, 1976). Risebrough et al. (1980) noted that DDT and PCB compounds had declined by an order of magnitude from 1970 to 1980 at selected stations in the Southern California Bight. Stabilization of PCB and DDT compounds in the Palos Verdes Peninsula-Los Angeles Harbor area at levels substantially above baseline conditions in California suggested continued inputs (Martin et al., 1980). Therefore, an increased sampling network to better define pollutant gradients in an area affected by these compounds, and to assess possible additional inputs to the study area was recommended.

The concentration of pp' DDE in mussels of the Los Angeles-Long Beach Harbor complex indicated certain local areas in the inner harbor, the Cabrillo Beach and site #5 areas were elevated (Figure 13). The

B-14



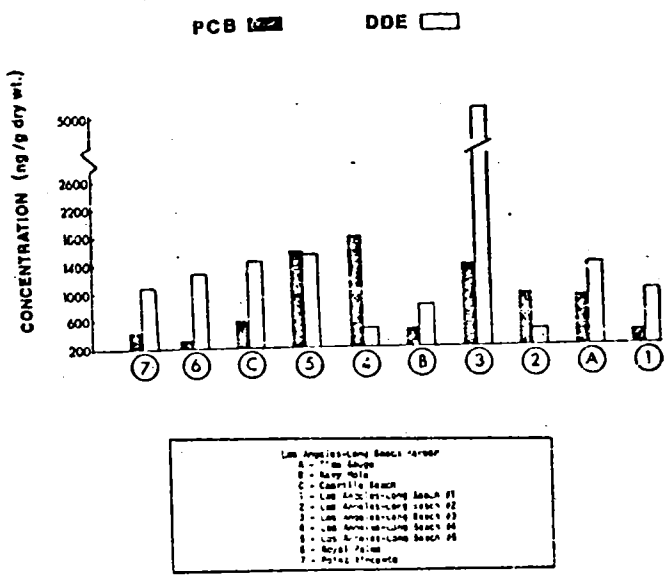


Figure 13. DDT and PCB concentrations in mussels from the 1980 Los Angeles-Long Beach Harbor and near coastal "intensive site survey, expressed as ng/g dry weight.

B-15

higher levels of pp' DDE in harbor areas might have been a result of inputs from spills or accidental events, more aerial or surface runoff inputs, or more accumulation from resuspension of previously deposited DDT compounds.

The pattern of proportionally higher concentrations of DDE and DDD analogs relative to DDT in biological samples has been used in the southern California area to characterize the pre-1970's discharge of DDT (MacGregor, 1974). At the time of discharge of DDT, the most abundant analog was pp' DDT. MacGregor (1974) reported that DDT in myctophid fish increased for a few years until metabolism and dispersion equalled input and then levelled off; pp' DDD acted in a similar manner, but at a lower level. Most of the increase in total DDT (=sum of metabolites) was caused by the increase in the persistent metabolite, DDE. The data reported by MacGregor (1974) showed a 12-fold increase in the amount of DDE relative to DDT between 1951 and 1966. This trend of increased DDE relative to DDT in fish tissue appeared to continue even after the cessation of the DDT discharge to the sewer system in 1972. Thus, the high ratio of DDE to DDT may reflect in part continued metabolism of DDT without replenishment (MacGregor, 1974), and the relative proportions of these analogs could be used to interpret the relative ages of DDT discharges. The order of abundance of DDT analogs in the Los Angeles-Long Beach Harbor samples was DDE, DDD, and DDT (Table 18). This pattern is typical of fishes, porpoises, and crustaceans, reported by MacGregor (1974) for samples from the ocean off southern California. Stout (1968) reported data for 17 samples representing seven species of marine fish. In these, DDE averaged

B-16

TABLE 18. Relative proportions of DDT at the 1980 Royal Palms, Los Angeles, and Long Beach Harbor intensive monitoring stations.

Station	DDT (ng/g)	%DDT	DDE (ng/g)	%DDE	DDD (ng/g)	%DDD	Total 3 (ng/g)
M. californianus							
Point Vincente (#7)	18	2	882	89	90	9	990
Royal Palms (#6)	18	1	1400	87	201	12	1619
Cabrillo Beach (C)	20	1	1720	90	173	9	1913
Tide Gauge (A)	16	1	1186	84	218	15	1420
Navy Mole (B)	10	1	894	84	158	15	1062
M. edulis							
Los Angeles-Long Beach #1	100	5	1550	83	220	12	1870
Los Angeles-Long Beach #2	44	5	420	45	477	50	941
Los Angeles-Long Beach #3	110	2	5070	92	340	6	5525
Los Angeles-Long Beach #4	99	12	470	59	229	29	798
Los Angeles-Long Beach #5	86	4	1610	71	580	25	2276

(52%), DDD (20%), and DDT (28%) of the total DDT. Following the cessation of DDT dumping into the ocean off Los Angeles in 1970, MacGregor reported a change in the DDD/DDT ratios: before 1970, most fish samples had higher amounts of DDT than DDD. After dumping ceased, the reverse was true. In examination of the Los Angeles-Long Beach Harbor data for DDT in mussels, it is clear that DDT contamination is not the result of recent inputs of pp' DDT, or of pp' DDT, that might result from transient inputs, according to MacGregor's (1974) criteria. It indicates that the degradation and persistence of DDT compounds of the Harbor will probably follow those patterns occurring in the coastal waters of southern California.

The pattern of PCB's in mussels from Los Angeles-Long Beach Harbor area was one of generally higher levels of PCB's when compared with mussels from nearshore southern California coastal waters. Within the harbor, no immediately obvious spatial pattern for PCB distribution was evident (Figure 13). In general, stations located in channels (LA-3 and LA-5) had higher values than stations in the outer harbor (Cabrillo Beach) or outside the harbor (Point Vincente). MacGregor (1974) stated that there were no trends with time for PCB in fish tissues during his seven (7) year survey from 1949-1966. The only indication of an areal relationship was that while the three stations closest to the White Point sewer outfall and the City of Los Angeles constituted only 8% of the total samples, they accounted for 34% of the fish containing more than 1000 ppb PCB (wet weight).

The pathway of entry of PCB's into mussels in the Los Angeles-Long Beach Harbor area is not fully understood. Young et al (19[illegible]

B-18

APPENDIX 6. Synthetic organic compound data for 1980 resident mussels (cont.).

Station	trans-chlordane	dacthal	op DDE	pp'DDE	op DDD	pp'DDD
M. californianus						
Trinidad Head	2.2			13		
Pygmy Forest	3.6			18		
Bodega Head	4.9			25		6.2
Duxbury Reef	6.4			8.6		5.8
James V. Fitzgerald	3.6			14		
Pacific Grove	5.2	2.7		54	12	21
J.P. Burns	2.5			27		
Royal Palms	13		100	1300	41	160
Santa Catalina Island-Ben Weston	1.5			14		
Santa Catalina Island-Empire	1.9		4.2	28		4.6
Corona Del Mar	21	3.4	21	220	9.6	34
Oceanside	33		14	390	27	100
M. edulis						
Elkhorn Slough	11	150	7.3	280	41	160
Los Angeles-Long Beach Site #4	24			470	29	200
Anaheim Bay	130	3.8	42	970	46	420

B-19

APPENDIX 6. Synthetic organic compound data for 1980 resident mussels (cont.).

Station	pp'DDMS	pp'DDMU	op DDT 1/	pp'DDT	dieldrin	endo-sulfan I
M. californianus						
Trinidad Head					7.3	2.3
Pygmy Forest					8.3	2.0
Bodega Head					14	2.4
Duxbury Reef					17	
James V. Fitzgerald					7.9	
Pacific Grove			5.2	11	4.8	8.4
J.P. Burns					2.5	
Royal Palms	19	67		18	3.7	
Santa Catalina Island-Ben Weston					1.0	
Santa Catalina Island-Empire				4.0		
Corona Del Mar		18	6.6	20	11	
Oceanside	17	19	20	71	22	6.3
M. edulis						
Elkhorn Slough	19	18	36	140	29	170
Los Angeles-Long Beach Site #4		52	26	99	13	
Anaheim Bay	51	51	56	200	11	2.2

1/ Tentative Identification - Confirmation by GC/MC Pending.

B-20

APPENDIX 7. Synthetic organic compound data for 1980 transplant mussels (cont.).

Station	trans-chlordane	dacthal	op DDE	pp'DDE	op DDD	pp'DDD
Humboldt Bay-North Samoa Bridge				6.3		15
Humboldt Bay-South Samoa Bridge	1.2			4.8		4.5
Humboldt Bay-Eureka Slough	3.2			11		3.0
Bodega Harbor				2.1		7.2
Bolinas Lagoon				21		10
Tomales Bay	1.3			19		12
San Francisco Bay-Angel Island	19	2.7	4.9	71	25	100
San Francisco Bay-Treasure Island	19	3.8	4.2	69	22	110
San Francisco Bay-Redwood City	24	3.2	5.9	52	9.3	46
San Francisco Bay-Dumbarton	23	9.2	11	99	5.6	34
Santa Cruz Harbor	15			55	8.2	50
Elkhorn Slough Bridge	4.4	2.9		96	8.1	32
Morro Bay-Upper Harbor	3.3	2.2		10		21
Morro Bay-Virg's	4.0			92	5.0	16
Channel Island Marina	22		5.6	290	21	100
Port Hueneme	12		7.2	200	11	130
Anacapa Island	4.4		3.7	42		7.6
Marina Del Rey	210		62	650	62	650
Los Angeles-Long Beach Tide Gauge	37		86	1100	38	180
Newport Harbor	42	36	39	880	60	430
Mission Bay	17		6.4	140	15	57
San Diego Harbor-Shelter Island	16			290	29	100
San Diego Harbor-G Street	29			110	13	81
San Diego Harbor-Coronado Bridge	29			120	22	78

B-21

APPENDIX 7. Synthetic organic compound data for 1980 transplant mussels (cont.).

Station	pp'DDMS	pp'DDMU	opDDT[1/]	pp'DDT	dieldrin
Humboldt Bay-North Samoa Bridge		6.5			5.4
Humboldt Bay-South Samoa Bridge					4.1
Humboldt Bay-Eureka Slough					5.9
Bodega Harbor					10
Bolinas Lagoon					4.7
Tomales Bay	29	11	6.6	11	34
San Francisco Bay-Angel Island	26	15	6.0	13	24
San Francisco Bay-Treasure Island	14	7.5	6.5	7.4	44
San Francisco Bay-Redwood City		13	10	5.2	35
San Francisco Bay-Dumbarton		6.1		4.5	11
Santa Cruz Harbor		5.0	3.0	12	21
Elkhorn Slough Bridge				5.9	8.0
Morro Bay-Upper Harbor					5.1
Morro Bay - Virg's		16		49	18
Channel Island Marina			8.8	34	11
Port Hueneme				4.1	5.6
Anacapa Island	97	67		92	91
Marina Del Rey	39	70		16	35
Los Angeles-Long Beach Tide Gauge	25	56		39	41
Newport Harbor		7.5		9.1	19
Mission Bay	13	26		26	20
San Diego Harbor-Shelter Island	11	13			13
San Diego Harbor-G Street	31	43			21
San Diego Harbor-Coronado Bridge					

1/ Tentative Identification - Confirmation by GC/MC Pending.

B-22

APPENDIX 9. Data for selected synthetic organic compounds in mussels from the 1980 Royal Palms and Los Angeles-Long Beach Harbor intensive site collections. 1/

Station		Resident/ Transplant	op DDE	pp' DDE	opDDD	pp'DDD	opDDT 2/	pp'DDT	total DDT 3/	PCB 1254
M. californianus										
Pt. Vincente	(#7)	Resident	62	820	28	62	-	18	1051	420
Royal Palms	(#6)	Resident	100	1300	41	160	-	18	1705	390
Cabrillo Beach	(C)	Resident	220	1500	44	130	-	20	2057	600
Tide Gauge	(A)	Transplant	86	1100	38	180	-	16	1529	490
Navy Mole	(B)	Transplant	94	800	28	130	-	10	1145	490
M. edulis										
Los Angeles-Long Beach #1		Resident	150	1400	40	180	-	100	1984	920
Los Angeles-Long Beach #2		Resident	-	420	57	420	-	44	1107	990
Los Angeles-Long Beach #3		Resident	170	4900	60	280	37	110	5711	1500
Los Angeles-Long Beach #4		Resident	-	470	29	200	26	99	876	1800
Los Angeles-Long Beach #5		Resident	110	1500	100	480	-	86	2460	1600

1/ Data are reported in ng/g on a dry weight basis. Lack of a reported value indicates that there were no detectable residues.

2/ Tentative Identification - Confirmation by GC/MS Pending.

3/ Total DDT = Σ op and pp' DDE + op and pp' DDD + op and pp' DDT

B-23

1822

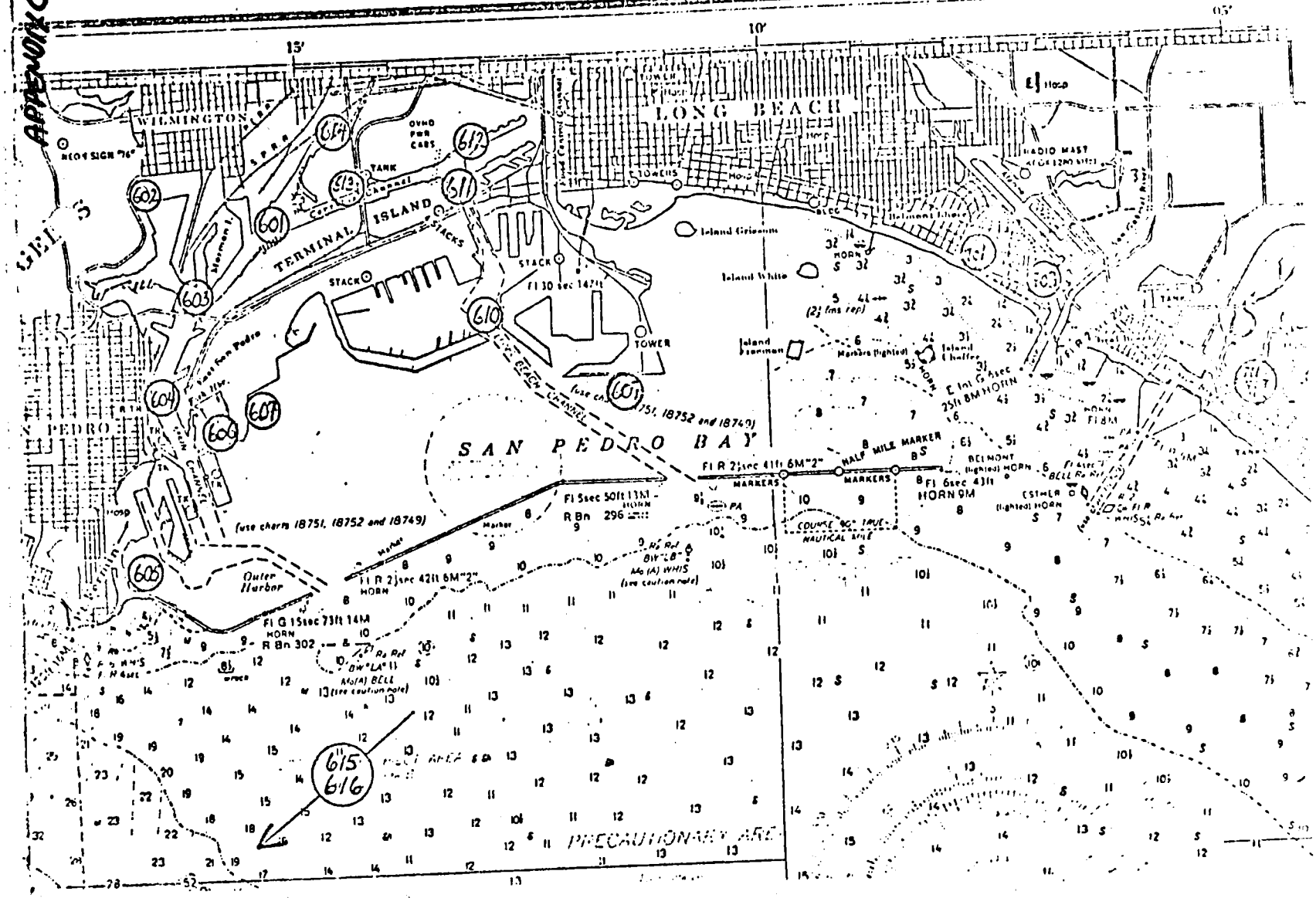
AUTHORITIES

...ls and Abbreviations see Chart No. 1

SAN PEDRO CHANNEL

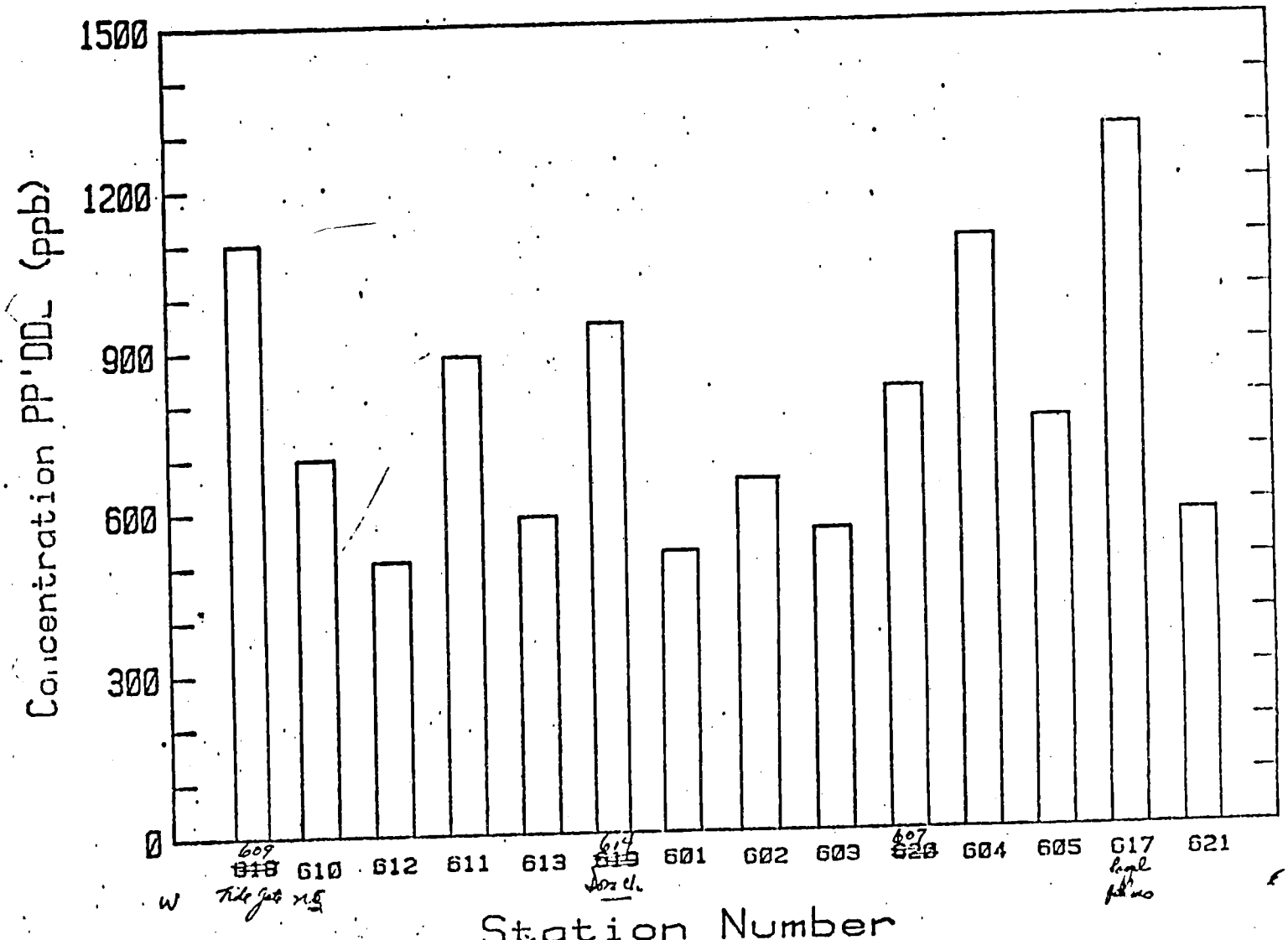
1st Ed., Mar. 1951 G 1953 S18

C-1



LOS ANGELES/LONG BEACH HARBOR 1981

C-2



C-3

Station Name	op DDD	pp'DDD	op DDE	pp'DDE	pp'DDMS
Elkhorn Slough					
Duck Club	46	140	13	450	
Sand Holt Br.	220(230)	800(890)	41(28)	2000(2200)	
Marina Del Rey	28	170	29	320	36
Port Hueneme	48	330		260	12
Channel Islands	17	94	15	240	
Los Angeles Harbor					
**National Steel	72	540	40	520	52
**West Basin	55	610	120	660	44
**Berth 133	41	300	81	560	35
**Gate X	51	430	190	1100	47
**Cabrillo Pier	20	81	86	760	27
**Outer Fish Harbor	19	80	110	770	40
**Terminal Island	13(11)	44(37)	110(89)	720(840)	21(19)
**Tide Gage	18	170	110	1100	21
**Pier F.	21	160	95	700	24
**S. Calif. Edison	27	84	150	890	37
**Channel #3	31	160	54	510	32
**Henry Ford Br.	41	340	89	590	47
**Dominguez Ch.	95	1100	78	950	36
**Whites Point	15	62	58	580	11
Royal Palms	20	170	88	1300	
Alamitos Bay					
Colorado Lagoon	39	280	230	460	
Pier 22	20	110	30	610	18

* PCB only
** DDT-PCB only

C-4

Station Name	pp'DDMU	op DDT	pp'DDT	dieldrin	endosulfan I
Elkhorn Slough					
Duck Club	12	57	330	46	260
Sand Holt Br.	20(37)	520(410)	1700(1800)	180(240)	770(890)
Marina Del Rey	30	22	38	19	
Port Hueneme	33	24	83	3.0	3.0
Channel Islands	10	22	84	1.0	2.2
Los Angeles Harbor					
** National Steel		38	96		
** West Basin	25	29	59		
** Berth 133	30	15	49		
** Gate X	65	15	41		
** Cabrillo Pier	40	4.5	13		
** Outer Fish Harbor	48				
** Terminal Island	33(33)		5.1(5.1)		
** Tide Gage	39		12		
** Pier F.	36	8.2	27		
** S. Calif. Edison	45	6.9	8.9		
** Channel #3	38	9.9	70		
** Henry Ford Br.	44	22	47		
** Dominguez Ch.	29	72	100		
** Whites Point	17		16		
Royal Palms	57			6.5	
Alamitos Bay					
Colorado Lagoon	43		94	67	
Pier 22	38	14	11	6.8	

* PCB only
** DDT-PCB only

EPA SUMMARY

Late 1981 State Mussel Watch Data

Los Angeles - Long Beach Harbor

Parts Per Billion

Station Name	Station #	DDT (%)	DDD (%)	DDE (%)	Total DDT (100%)
National Steel	601	134 (10)	612 (47)	560 (43)	1306
West Basin	602	88 (6)	665 (43)	780 (51)	1533
Berth 133	603	64 (6)	341 (33)	641 (61)	1046
Gate X	604	56 (3)	481 (26)	1290 (71)	1827
Cabrillo Pier	605	18 (2)	101 (10)	846 (88)	965
Outer Fish Harbor	606	- -	99 (10)	880 (90)	979
Terminal Island	607	5 (1)	57 (6)	830 (93)	892
Tide Gauge	609	12 (1)	188 (13)	1210 (86)	1410
Pier F	610	35 (3)	181 (18)	795 (79)	1011
So. Cal. Edison	611	16 (1)	111 (10)	1040 (89)	1167
Channel #3	612	80 (9)	191 (23)	564 (68)	835
Henry Ford Br.	613	69 (6)	381 (34)	679 (60)	1129
Dominguez Channel	614	172 (7)	1195 (50)	1028 (43)	2395
Whites Point	615	16 (2)	77 (11)	638 (87)	731

Ratio (%) Calculation

Metabolite (DDT, DDD, or DDE) divided by Total DDT (DDT + DDD + DDE) = % Metabolite

C-5

APPENDIX D

COASTAL WATER RESEARCH PROJECT

Annual Report for the Year Ended 30 June 1975

Southern California Coastal
Water Research Project
1500 East Imperial Highway
El Segundo, California 90245
(213) 322-3000

D-1

David R. Young and Deirdre J. McDermott

AERIAL FALLOUT OF DDT

The comparison of chlorinated hydrocarbon inputs presented in the previous article indicates that, during 1973 and 1974, aerial fallout contributed almost as much DDT and its residues to the coastal ecosystem as did municipal wastewater, the largest single source of the pesticide. In light of the decreasing concentrations of DDT in the municipal effluents, it appears that aerial transport will be the dominant input route of the future. Thus, with the support of the U.S. Environmental Protection Agency, we have investigated the fallout rates of chlorinated hydrocarbons onto the Bight in considerable detail over the last 2 years.

Utilizing a glass plate and mineral oil collection technique first developed by Dr. Vance McClure (National Marine Fisheries Service, Tiburon, California), approximately 1,000 samples were taken in replicate 1-week collections made during two 13-week periods at 14 coastal stations and 6 island stations between Point Conception and the U.S./Mexico border. These samples have yielded a large body of data on several DDT compounds in dry aerial fallout, at levels free of apparent chromatographic interferences or significant contributions from analytical blanks.

The results for p,p,'-DDT, and p,p'-DDE (plus p,p'-DDD for the second survey) have been converted to estimated mean daily fluxes (10^{-9} g/sq m/day) for each sampling, applying a collection efficiency factor of 50 percent. The Wilcoxon signed-rank test was used to determine if there was any statistically significant difference between the two seasonal values of total DDT fallout onto the Bight. None was demonstrated at 95 percent confidence level; therefore, the weekly data for the individual components were averaged over the entire 26-week collection period. Figure 1 presents the resultant mean for total DDT. The average ratio of p,p'-DDT to o,p'-DDT observed in the Bight was 2.5 to 1, and these two isomers constituted approximately 70 percent of the "total" measurable flux of DDT compounds onto the Bight. In contrast, p,p'-DDE is the principal component

D-2

observed in JWPCP wastewater and in the ocean bottom sediments around the site of this major discharge: Approximately three-quarters of the total DDT is made up of p,p'-DDE in the surface sediment samples.

Northern Baja California is often used as a control zone in Project studies; thus, during the first seasonal collection, a few weekly samples also were taken by student volunteers at the Institution for Oceanographic Investigations, Universidad Autonoma de Baja California, in Ensenada, Mexico. The results indicated that one of the highest coastal flux values for total DDT observed in the Bight during summer 1973 occurred at Ensenada. This is an agricultural region of the Baja California peninsula, and these higher fallout values appear to reflect greater or more recent local usage of DDT than to the north.

One of the most striking results of this Bight-wide survey was that, with the exception of the Ensenada results, the total DDT fallout values generally increased toward Los Angeles. This was surprising, as the major agricultural areas of the coastal plain lie to the north and south of this highly-urbanized region. Because the results of this research had indicated that dry aerial fallout was a relatively important source of DDT compounds to the Bight, the project conducted its own fallout survey within the Los Angeles Basin to further investigate this finding.

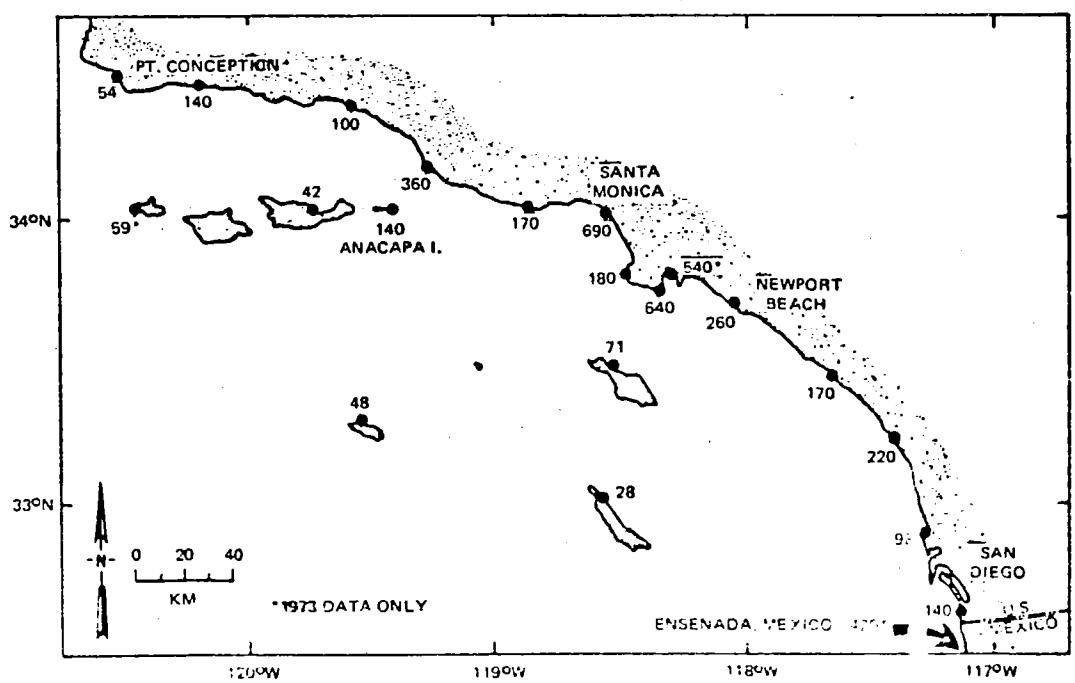


Figure 1. Average flux of total DDT (10^{-9} g/sq m/day) in dry aerial fallout, 1973-1974.

D-3

Between 26 April and 24 May 1974, we sampled 24 stations during 4 successive weeks. Because of the past history of dramatic DDT pollution of the Bight, apparently as a result of waste discharges from Montrose Chemical Company, four stations were established within a few blocks of this industrial plant in the city of Torrance. Four sites also were established around the sanitary landfill in Rolling Hills Estates on the Palos Verdes Peninsula, operated by the County Sanitation Districts of Los Angeles County. It is reported that this landfill received DDT wastes from the Montrose plant up until about 1972. In addition, four sites were established around a private sanitary landfill owned by Ben K. Kazarian and located near the city of West Covina where the Montrose wastes are now taken.

In this survey, both the DDT constituents and 1254 PCB were clearly identified at levels at least an order of magnitude above those found in process blanks. The results showed two regions of relatively high DDT fallout, located in the vicinity of the Montrose plant and the Rolling Hills sanitary landfill. The highest of the values in each region generally occurred at the south or southeast stations. As the prevailing coastal winds are from the northwest, this suggests two separate sources. Wind data for the interior of the Basin are being analyzed to further investigate this subject.

In light of the large gradients in DDT fallout rates that were observed, and the implications regarding the sources, the survey was repeated during 2 weeks in September 1974; two additional stations were included in the pattern around the Montrose plant. The September DDT data were similar to those of the previous spring and indicate little seasonal effect.

The occurrence of an occasional anomalous value can strongly bias a small-sample mean, so for this basin study, we assumed the median of the six weekly values to be most representative of the fallout flux at a given station. These values for total DDT and 1254 PCB are illustrated in Figures 2 and 3, respectively.

The data presented above indicate an apparent relationship between the DDT fallout distribution and the location of a major manufacturing facility and one of its past waste disposal sites. However, the level of DDT in the dry aerial fallout around the present disposal site (the Kazarian landfill) is not any higher than levels at other Basin stations. As the two principal constituents of the pesticide itself are p,p'-DDT and o,p'-DDT, we examined these two products of the manufacturing process in greater detail. We found a considerably larger value for the ratio of p,p'-DDT to o,p'-DDT around the two regions of highest fallout (10 sites) than in the rest of the Basin

0-4

(15 sites); median values for the two groups are 5.0 and 3.2, respectively. This ratio may be an indication of the relative "freshness" of the DDT constituents collected on our fallout plates. Similarly, the para and ortho isomers together constitute the largest percentage of total measurable DDT at these 10 sites; median percentages for the two groups are 85 percent and 63 percent. This too

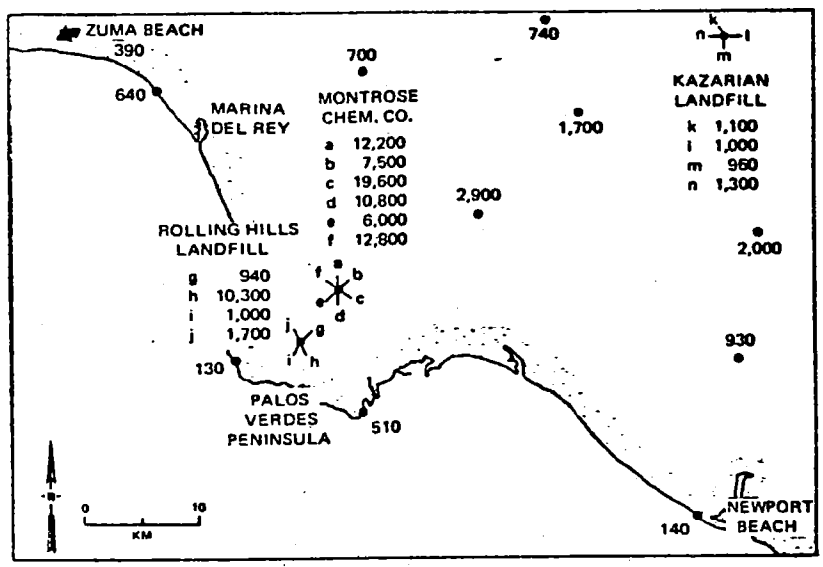


Figure 2. Median flux of total DDT (10^{-9} g/sq m/day) in dry aerial fallout collected during 6 weeks of 1974.

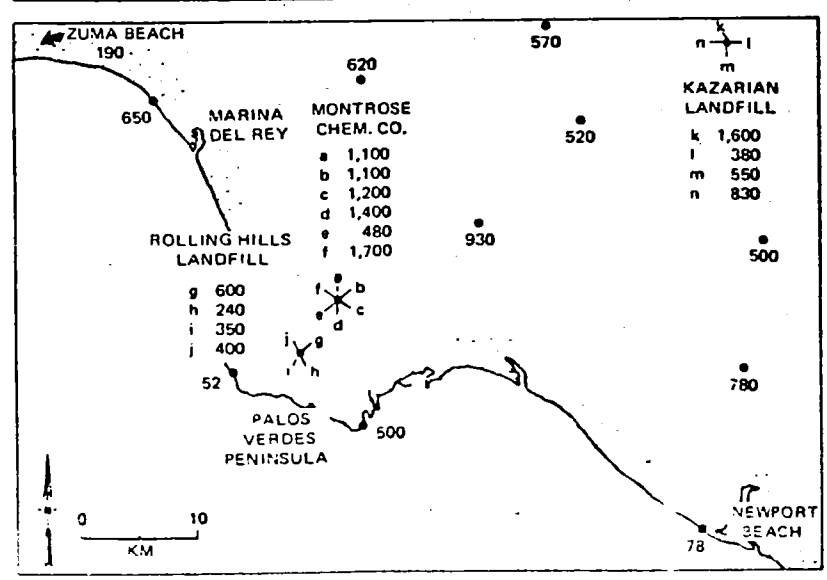


Figure 3. Median flux of 1254 PCB (10^{-9} g/sq m/day) in dry aerial fallout collected during 6 weeks of 1974.

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may be related to effects of "weathering." Finally, to determine if the relatively high DDT fallout values around the manufacturing plant and its past waste depository could be due merely to higher deposition of particulates, we have normalized the values against 1254 PCB, which is not manufactured by Montrose Chemical Co. Distinctively higher values for this ratio are observed around the plant and the Rolling Hills landfill (median: 6.0) than in the rest of the basin (median: 1.2). Thus, it appears that the gradients in DDT fallout values we have observed do indicate two regions that are potentially important sources of DDT compounds to the Los Angeles Basin and the adjacent Southern California Bight.

Two methods were used to calculate the amount of total DDT falling onto the basin annually. The first involved a strict linear interpolation between data points. For those stations where there were two or more sampling sites, the median flux was used to represent the station. It should be noted that in the case of the Rolling Hills landfill, one site has a significantly higher flux than the other three sites. As this value is the median of six weekly values, and this site had the highest weekly flux reported for the entire Basin study, it appears that the site represents a secondary source of DDT. However, the median flux of $1,400 \times 10^{-9}$ g DDT/sq m/day is a more representative value for that station. Because the location of sampling sites and the high values at Montrose bias the fallout estimate of 2.2 metric tons/yr derived from our contours, we consider this to be an upper limit. The median flux for the entire Basin, 930×10^{-9} g/sq m/day, was used to estimate a lower limit. The fallout estimate calculated using this value is 0.5 metric tons/yr, resulting in an estimated range of 0.5 to 2.2 metric tons/yr.

One of the most important aspects of these findings is that there still may be a significant release of DDT wastes to the southern California environment from the manufacture of this pesticide in Los Angeles County, even though the discharge of liquid wastes to the County sewer system has been stopped. During 1974, the average level of total DDT in JWPCP final effluent was 3.0 µ/l, which alone exceeds the level allowed by the California State Water Resources Control Board "Ocean Plan" (2 µg/l on a 50 percent occurrence basis) for total identifiable chlorinated hydrocarbons in such wastewaters. The corresponding mass emission rate for total DDT was 1,400 kg/yr. We have estimated that a similar quantity (1,300 kg) of DDT compounds fell onto the coastal waters annually during 1973-74. A significant fraction of this material may have emanated from DDT wastes produced during manufacture of the pesticide in Los Angeles County, either directly from the plant or from its original land waste disposal site. Thus, a unified con-

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trol plan to reduce marine inputs of this pollutant would require that attention also be paid to these potential sources of DDT to the atmosphere in Los Angeles Basin.

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APPENDIX E

EMERGENCY RESPONSE REPORT

TO: Chris Vais, ERC, EPA

FROM: Emily Pimentell, TAT, Roy F. Weston, Inc.

SUBJECT: DDT Sampling at Montrose Chemical Corp., Torrance, CA

TDD: 9-8211-1013

DATE: November 23, 1982

PERSONS CONTACTED: Steve Simanonak, Field Inspection Section, EPA
Richard Gosset, Southern Calif., Coastal Water Research Project (213-435-7071)
Pat Herschelman, Southern California, Coastal Water Res. Project
John Wakamatsu, Los Angeles Department of Water and Power (213-481-4634)
John Mitchell, Los Angeles Flood Control District (213-226-4386)

On Monday 8 November, 1982 at 1000 hours, Steven Simanonak requested TAT's assistance in obtaining soil and storm-water runoff samples down-gradient from the Montrose Chemical Corporation in Torrance, Calif. Simanonak and Pimentell arrived in Los Angeles late Monday, and proceeded to prepare the sampling equipment in anticipation of a rain storm early Tuesday morning.

Background

Montrose Chemical Corporation was, until recently the sole DDT manufacturing plant in the United States. In August, 1982, Montrose notified the Los Angeles Department of Health Services (DOHS) that it was phasing down the production of DDT, and expected to close down soon. The Environmental Protection Agency (EPA) has not been formally notified of the plants' plans to close, but it is believed that DDT is currently no longer being manufactured. The concern at this time is that due to poor housekeeping during packing and shipping operations, the plants' grounds are heavily contaminated with DDT. Runoff from the plant is suspected of contributing significantly to DDT contamination in the Dominguez Channel. The point of entry into the Dominguez Channel is via a catch-basin below the plant which drains through a series of laterals prior to discharging into the main channel. Runoff from the plant drains through a narrow, unlined channel, ponds; then overflows into the catch-basin located approximately 500ft. from the chemical plant.

The Los Angeles Flood Control District (LAFCD) has obtained sampling data from the Torrance lateral (drainage route between the catch-basin and the Dominguez Channel) which suggests that DDT concentrations are higher during storm events. This data contributed to EPA's decision to investigate DDT contaminated runoff from the Montrose Facility.

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Sampling Action

The objective in collecting the storm-water runoff samples was to demonstrate that DDT is actually draining from the plant and entering navigable waters. Standards for the discharge of DDT into navigable waters of the United States are non-existent. Under Sec. 311 of the Clean Water Act, any discharge of DDT is regarded as an illegal discharge.

Water samples were collected at four points below the chemical facility. A street runoff water sample up-gradient to the plant was collected as a background sample. Samples were collected in ½-gallon hexane rinsed glass bottles. In addition to Simanonak and Pimentell, Richard Gossett and Pat Hershelman of the Southern California Coastal Water Research Project assisted in collecting the water samples during Tuesday's storm. While collecting the water samples, an unidentified Montrose Chemical Corporation employee inquired as to why we were collecting samples. Simananok informed him he was an EPA representative. Samples were not taken off Montrose property, therefore split water samples were not taken. The Montrose employee did take his own water sample.

Soil samples were collected Wednesday, below the chemical plant to define the extent of DDT contamination at the soil surface. Samples were collected by removing one inch of surface soil and filling eight-ounce size glass jars. Since the property directly between the catch-basin and Montrose belongs to the Los Angeles Department of Water and Power, splits were provided to their representative, Mr. John K. Nakamatsu.

Details regarding the EPA traffic report sample members, sample locations and time of sampling are given in Table I and Map A. Samples were mailed via Federal Express to California Analytical Lab in Sacramento at the end of each sample day.

Status and Recommendations

Pending analytical results, TAT will review storet data on DDT water analysis available through the LAFCD, and gather any rain and drainage basin data which can be used to obtain an estimate of gross DDT loading into the Dominguez Channel. Contacts within the Long Beach Harbor Research Project will also be pursued to determine whether any data is available on DDT levels in sediment and water in Long Beach Harbor.

Although the samples obtained during this sampling trip may be sufficient to place the "burden of proof" on Montrose Chemical Corporation regarding illegal DDT discharge from their facility, it may be prudent to plan a comprehensive sampling plan designed to define all possible flow routes in and out of the facility to eliminate any question regarding the origins of DDT contamination. Concurrently, discussion regarding appropriate remedial action should be pursued.

E-2

TABLE I

SUMMARY OF SOIL AND WATER SAMPLES TAKEN AT THE MONTROSE CHEMICAL CORPORATION

EPA TRAFFIC REPORT NUMBER	MEDIUM	SAMPLE STATION	SAMPLE TIME *	SAMPLE LOCATION
2132	Soil	A	1100 hrs.	Northwest of drainage channel below Montrose
2133	Soil	B	1045 hrs.	Drainage channel below Montrose
2134	Soil	C	1105 hrs.	East of drainage channel below Montrose
2135	Soil	D	1110 hrs.	Drainage channel
2136	Soil	E	1118 hrs.	Drainage channel
2137	Soil	F	1140 hrs.	Wide point of drainage channel
2138	Soil	G	1145 hrs.	Wide point of drainage channel
2139	Soil	H	1128 hrs.	Railroad "Y" adjacent water ponding area
1663	Soil	I	1150 hrs.	Flat part of drainage
1662 duplicate	Soil	H	1130 hrs.	Railroad "Y" adjacent water ponding area
9-2122	Water	3	755 hrs.	Farmers Brothers catch basin
[illegible]	Water	[illegible]	[illegible] hrs.	Drainage channel below Montrose
[illegible]	Water	[illegible]	[illegible] hrs.	Drainage channel below [illegible]

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TABLE I

SUMMARY OF SOIL AND WATER SAMPLES TAKEN AT THE MONTROSE CHEMICAL CORPORATION

EPA TRAFFIC REPORT NUMBER	MEDIUM	SAMPLE STATION	SAMPLE TIME*	SAMPLE LOCATION
9-2125	Water	3	1156 hrs.	Farmers Brothers catch basin
9-2126 duplicate	Water	3	1156 hrs.	Farmers Brothers catch basin
9-2127	Water	7	1240 hrs.	Storm drain up-gradient from Montrose at Knox Dr.
9-2128	Water	5	1222 hrs.	Flood control project "685" daylight near Brody Ave.
9-2129	Water	6	1247 hrs.	Torrance Lateral at Main St.
9-2130 Blank	Water	1	1330 hrs.	Blank filled at drainage channel leaving Montrose
9-2131	Water	2	1345 hrs.	Railroad "V" pondi area

* Water samples collected Tuesday November 9, 1982
Soil samples collected Wednesday November 10, 1982

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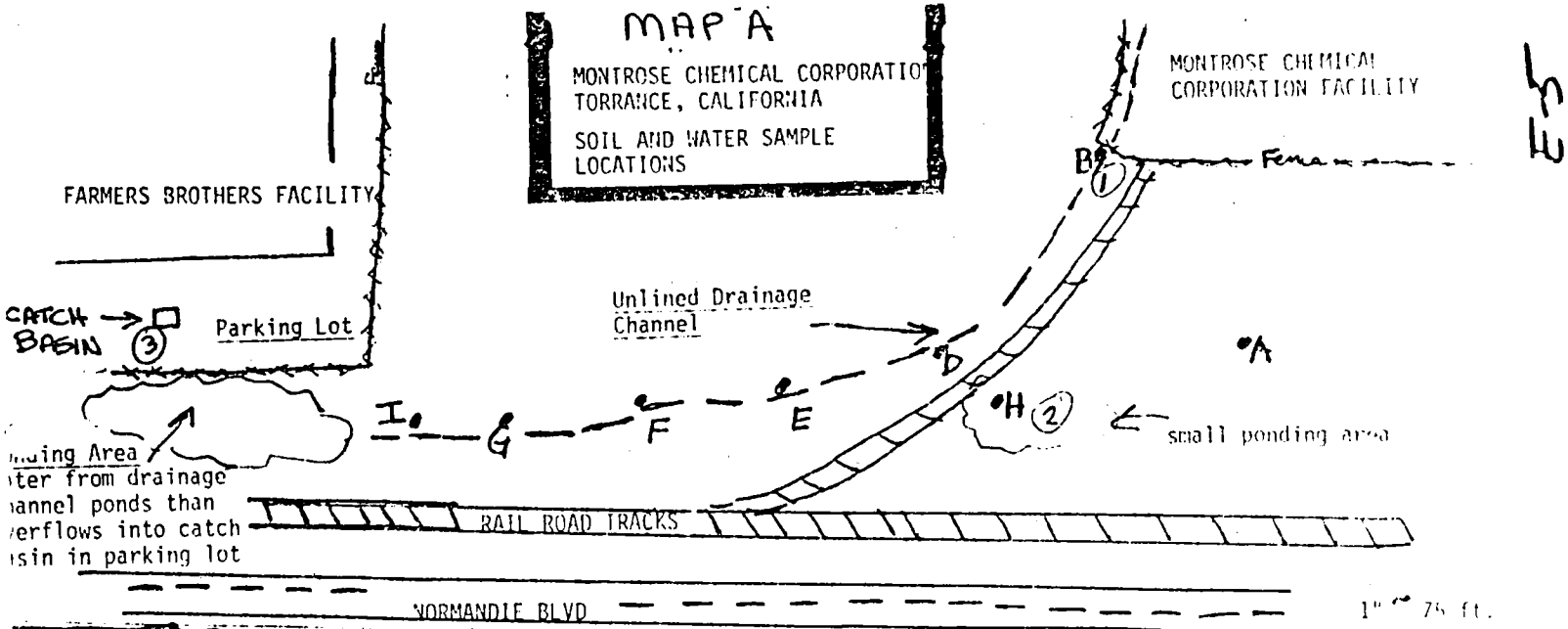
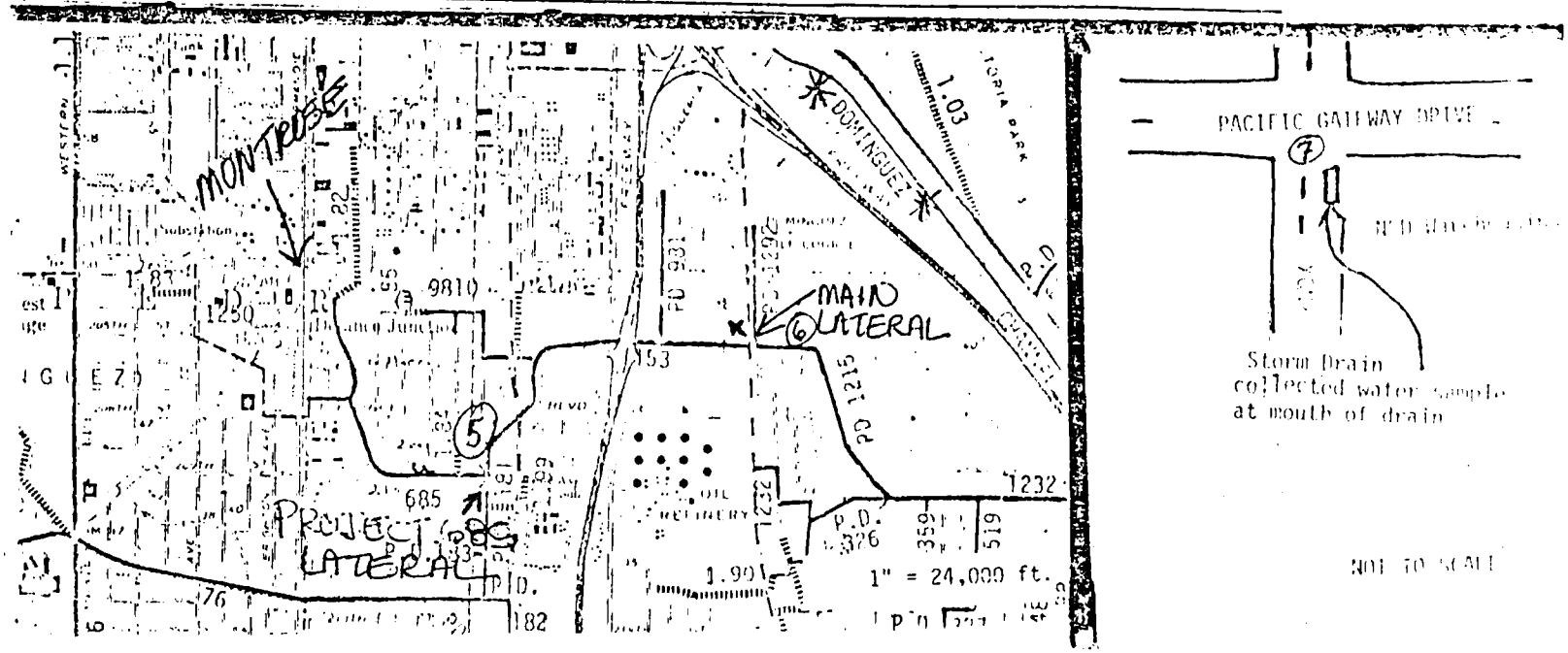
MAP A

MONTROSE CHEMICAL CORPORATION
TORRANCE, CALIFORNIA

SOIL AND WATER SAMPLE LOCATIONS



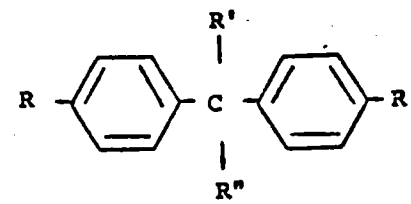


APPENDIX F

DDT and Its Metabolites

DDT refers to technical DDT, which is usually composed of:

77.1% p,p'-DDT
14.9% o,p'-DDT
0.3% p,p'-DDD
0.1% o,p'-DDD
4.0% p,p'-DDE
0.1% o,p'-DDE
3.5% unidentified compounds



		R	R'	R"
DDT	1,1'-(2,2,2-trichloroethylidene)-bis/4-chlorobenzene/	-Cl	-H	$-CCl_3$
DDE	1,1'-(2,2-dichloroethenylidene)-bis/4-chlorobenzene/	-Cl	None	$=CCl_2$
DDD	1,1'-(2,2-dichloroethylidene)-bis/4-chlorobenzene/	-Cl	-H	$-CHCl_2$
DDMU	1,1'-(2-chloroethenylidene)-bis/4-chlorobenzene/	-Cl	None	$=CHCl$
DDMS	1,1'-(2-chloroethylidene)-bis/4-chlorobenzene/	-Cl	-H	$-CH_2Cl$
DDNU	1,1-bis(4-chlorophenyl) ethylene	-Cl	None	$=CH_2$
DDOH	2,2-bis(4-chlorophenyl) ethanol	-Cl	-H	$-CH_2OH$
DDA	2,2-bis(4-chlorophenyl)-acetic acid	-Cl	-H	-C-OH ‖ O

SOURCE: Ambient Water Quality Criteria for DDT
EPA Report Number 440/5-80-038, p. A-2.

Physical Properties

The general physical properties of the DDT isomers are given below:

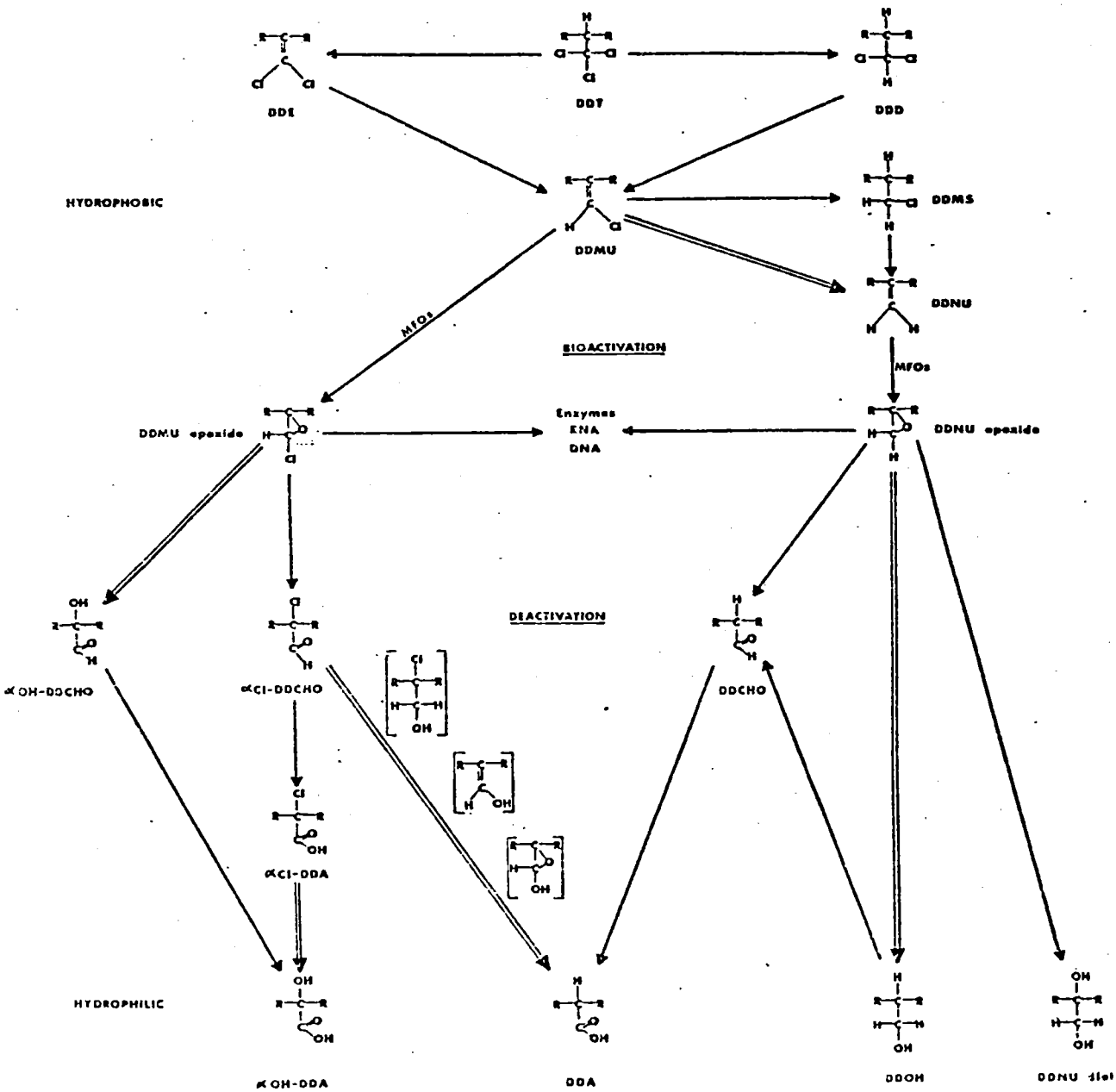
Molecular weight (Windholz, M. (ed.), 1976)	354.5
Melting point (Gunther and Gunther, 1971)	108.5-109.0°C (pp') 74-74.5°C (op')
Boiling Point (Gunther and Gunther, 1971)	185°C (pp')
Vapor pressure (Martin, 1972)	1.9×10^{-7} torr (pp') at 25°C
(Spencer, 1975)	7.3×10^{-7} torr (pp') at 30°C 5.5×10^{-6} torr (op') at 30°C
(Metcalf, 1972) at 20°C	1.5×10^{-7} torr (pp') at 20°C
Solubility in water at 25°C (Weil et al., 1974)	5.5 ppb (pp') 26 ppb (op')
(Biggar and Riggs, 1974)*	25 ppb (pp') 85 ppb (op')
Metcalf, 1972)	~2 ppb
(Bowman et al., 1960)	<1.2 ppb (pp')
Log octanol/water partition coefficient (O'Brien, 1974)	6.19 (pp', calc.)
(Kengaga and Goring, 1978)	5.98
(Wolfe et al., 1977)	4.89
(Kapoor et al., 1973)	3.98 (pp', measured)

*Particle size <5.0 μm.

SOURCE: Ambient Water Quality Criteria for DDT
EPA Report Number 440/5-80-038, p. A-3.

F-2

METABOLISM AND DETOXIFICATION OF DDT



Modified from Reid et al. Chem.-Biol. Interact 35:109-126, 1981) by Brown et al. (1991).

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APPROXIMATE COMPOSITION OF TECHNICAL DDT

COMPOUND	APPROXIMATE PERCENTAGE
1,1,1-Trichloro-2,2-bis(p-chlorophenyl) ethane (p,p'-DDT)	63-77
1,1,1-Trichloro-2-(o-chlorophenyl-2-(p-chlorophenyl) ethane (o,p'-DDT)	8-21
1,1-Dichloro-2,2-bis(p-chlorophenyl) ethane (p,p'-TDE)	0.3-4.0
1,1-Dichloro-2-(o-chlorophenyl)-2-(p-chlorophenyl) ethane (o,p'-TDE)	0.04
1-o-Chlorophenylethyl-2-trichloro-p-chlorobenzene sulfonate	0.1-1.9
2-Trichloro-1-p-chlorophenylethanol	0.2
Bis(p-chlorophenyl) sulfone	0.03-0.6
α -Chloro- α -p-chlorophenylacetamide	0.01
α -Chloro- α -o-chlorophenylacetamide	0.01
Chlorobenzene	0.3
p-Dichlorobenzene	0.1
1,1,1,2-Tetrachloro-2-(p-chlorophenyl) ethane	present
Sodium p-chlorobenzene sulfonate	0.02
Ammonium p-chlorobenzene sulfonate	0.01
Inorganic	0.01-0.1
Unidentified and losses	5.1-10.6

SOURCE: Ottinger, et al., "Recommended Methods of Reduction Neutralization, Recovery, or Disposal of Hazardous Waste - Volume V," 1973.

SECONDARY SOURCE: Draft Environmental Impact Statement for the Safe Collection, Transportation, and Final Disposal of U.S. Dept. of Defense Stocks of DDT. Prepared by Louis Berger & Associates for the Defense Logistics Agency, June 1980, p. C-4.

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Production and waste schematic for DDT (Montrose Chemical Company)

Source: Wastewater Treatment Technology, Documentation for [illegible], pp. [illegible], 1979, p. 12.

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APPENDIX G

United States
Environmental Protection
Agency

Office of Water
Regulations and Standards
Criteria and Standards Division
Washington DC 20460

EPA 440/5-80-038
October 1980

EPA

Ambient Water Quality Criteria for DDT

FOREWORD

Section 304 (a)(1) of the Clean Water Act of 1977 (P.L. 95-217), requires the Administrator of the Environmental Protection Agency to publish criteria for water quality accurately reflecting the latest scientific knowledge on the kind and extent of all identifiable effects on health and welfare which may be expected from the presence of pollutants in any body of water, including ground water. Proposed water quality criteria for the 65 toxic pollutants listed under section 307 (a)(1) of the Clean Water Act were developed and a notice of their availability was published for public comment on March 15, 1979 (44 FR 15926), July 25, 1979 (44 FR 43660), and October 1, 1979 (44 FR 56628). This document is a revision of those proposed criteria based upon a consideration of comments received from other Federal Agencies, State agencies, special interest groups, and individual scientists. The criteria contained in this document replace any previously published EPA criteria for the 65 pollutants. This criterion document is also published in satisifaction of paragraph 11 of the Settlement Agreement in Natural Resources Defense Council, et. al. vs. Train, 8 ERC 2120 (D.D.C. 1976), modified, 12 ERC 1833 (D.D.C. 1979).

The term "water quality criteria" is used in two sections of the Clean Water Act, section 304 (a)(1) and section 303 (c)(2). The term has a different program impact in each section. In section 304, the term represents a non-regulatory, scientific assessment of ecological effects. The criteria presented in this publication are such scientific assessments. Such water quality criteria associated with specific stream uses when adopted as State water quality standards under section 303 become enforceable maximum acceptable levels of a pollutant in ambient waters. The water quality criteria adopted in the State water quality standards could have the same numerical limits as the criteria developed under section 304. However, in many situations States may want to adjust water quality criteria developed under section 304 to reflect local environmental conditions and human exposure patterns before incorporation into water quality standards. It is not until their adoption as part of the State water quality standards that the criteria become regulatory.

Guidelines to assist the States in the modification of criteria presented in this document, in the development of water quality standards, and in other water-related programs of this Agency, are being developed by EPA.

STEVEN SCHATZOW
Deputy Assistant Administrator
Office of Water Regulations and Standards

G-2

CRITERIA DOCUMENT

DDT AND METABOLITES

CRITERIA

Aquatic Life

DDT

For DDT and its metabolites the criterion to protect freshwater aquatic life as derived using the Guidelines is 0.0010 µg/l as a 24-hour average and the concentration should not exceed 1.1 µg/l at any time.

For DDT and its metabolites the criterion to protect saltwater aquatic life as derived using the Guidelines is 0.0010 µg/l as a 24 hour average and the concentration should not exceed 0.13 µg/l at any time.

TDE

The available data for TDE indicate that acute toxicity to freshwater aquatic life occurs at concentrations as low as 0.6 µg/l and would occur at lower concentrations among species that are more sensitive than those tested. No data are available concerning the chronic toxicity of TDE to sensitive freshwater aquatic life.

The available data for TDE indicate that acute toxicity to saltwater aquatic life occurs at concentrations as low as 3.6 µg/l and would occur at lower concentrations among species that are more sensitive than those tested. No data are available concerning the chronic toxicity of TDE to sensitive saltwater aquatic life.

DDE

The available data for DDE indicate that acute toxicity to freshwater aquatic life occurs at concentrations as low as 1,050 µg/l and would occur at lower concentrations among species that are

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more sensitive than those tested. No data are available concerning the chronic toxicity of DDE to sensitive freshwater aquatic life.

The available data for DDE indicate that acute toxicity to saltwater aquatic life occurs at concentrations as low as 14 ug/l and would occur at lower concentrations among species that are more sensitive than those tested. No data are available concerning the chronic toxicity of DDE to sensitive saltwater aquatic life.

Human Health

For the maximum protection of human health from the potential carcinogenic effects due to exposure of DDT through ingestion of contaminated water and contaminated aquatic organisms, the ambient water concentration should be zero based on the non-threshold assumption for this chemical. However, zero level may not be attainable at the present time. Therefore, the levels which may result in incremental increase of cancer risk over the lifetime are estimated at 10^{-5}, 10^{-6} and 10^{-7}. The corresponding recommended criteria are 0.24 ng/l, 0.024 ng/l, and 0.0024 ng/l, respectively. If the above estimates are made for consumption of aquatic organisms only, excluding consumption of water, the levels are 0.24 ng/l, 0.024 ng/l, and 0.0024 ng/l, respectively.

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Appendix H

COASTAL WATER RESEARCH PROJECT

Biennial Report for the years 1981-1982

edited by
Willard Bascom

Southern California Coastal
Water Research Project
646 W. Pacific Coast Highway
Long Beach, California 90806
(213) 435-7071

H-1

Richard W. Gosset, Harold W. Puffer, Robert H. Arthur,
Jennifer F. Alfafara and David R. Young

LEVELS OF TRACE ORGANIC COMPOUNDS IN SPORTFISH FROM SOUTHERN CALIFORNIA

The most important consideration in any study of contaminants in the environment is the question of whether human health is endangered. After considering ways in which Southern Californians might be exposed to significant levels of toxicants, we decided that the greatest hazard would come from eating fish containing DDT, polychlorinated biphenyls (PCB),or benzo(a)pyrene (BaP). In the research described here, we replicated the catching and cooking of fish by the subpopulation that was most likely to be exposed. Then we measured the concentrations of these and other trace organic compounds in the seafood and estimated the rate at which these contaminants could be consumed annually. We found that concentrations of DDT and PCB were elevated in sportfish residing in areas near sewage outfalls or in the Los Angeles Harbor. These levels do not exceed the World Health Organization 1971 recommended maximum safe daily intake of 5 ug/kg/day. BaP was not present in any of the samples and of all the species analyzed, white croaker had the highest levels of contaminants.

The sediments adjacent to the coast of southern California are contaminated with trace organic compounds whose main source is the submarine outfalls. Project research also has shown that certain trace organics such as DDT's and PCB's have the ability to bioaccumulate in animals commonly consumed by man. For example, white croaker sampled by trawls taken near the Los Angeles County (JWPCP) outfall in April 1975 contained mean concentrations of 39 mg/ wet kg Total DDT and 2.8 mg/wet kg Total PCB (SCCWRP, unpublished data).

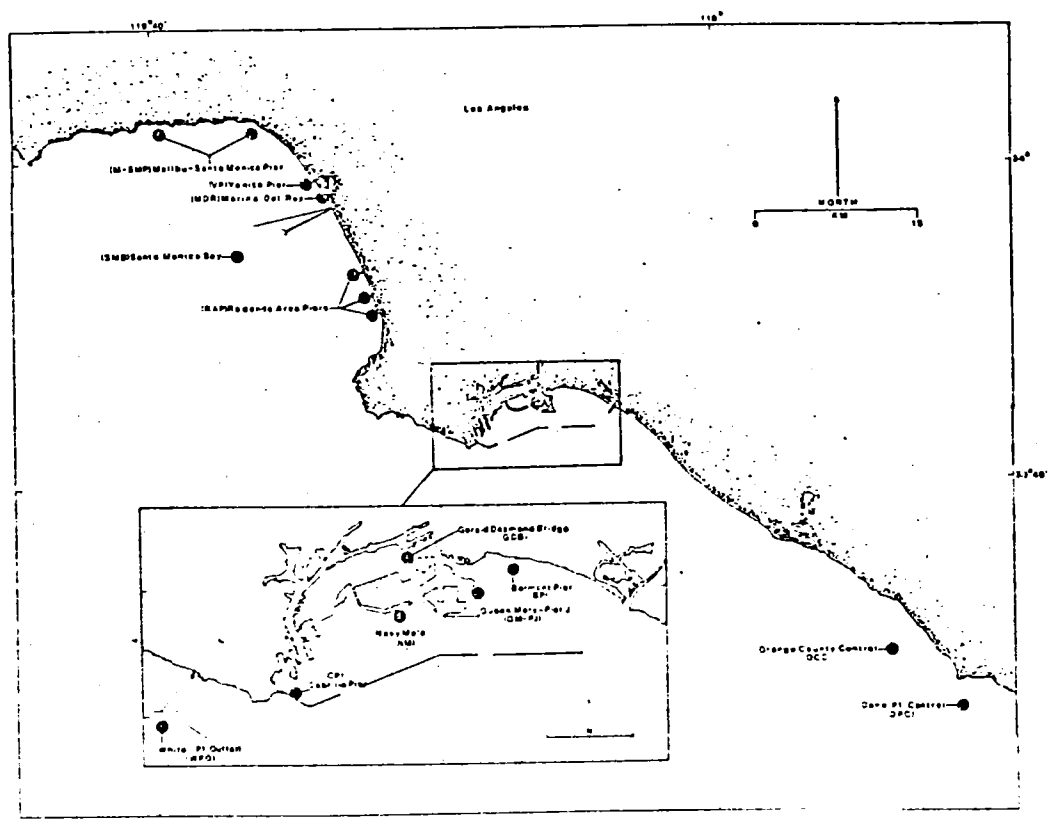
These results became of concern in 1978 when a survey of southern California sportfishermen conducted by the California Department of Fish and Game (Wine 1979) revealed that one-million angler trip hours per year were expended on fishing effort and that 30% of the fish caught were white croaker. The Department of Fish and Game did not attempt to determine the final disposition or use of fish being caught, but in 1980 the University of Southern California carried out an independent survey to assess the catch and consumption rates of sportfishermen (Puffer *et al.* 1981, 1982). The results of the USC survey indicated that there exists a subpopulation of sportfishermen along the southern California coast that catch and consume fish on a regular basis (14% go fishing 3-7 times week). The survey also indicated that the median consumption rate for all species combined was 37 g day person (approximately twice the national average) and that pan-frying was the most common method of cooking.

H-2

METHODS

White croaker (*Genyonemus lineatus*) were sampled from eleven of the twelve stations used in the USC consumption survey (Figure 1), plus two coastal control stations known to have relatively lower chlorinated hydrocarbon inputs (Word and Mearns 1979). Five of these stations were chosen for more intensive sampling of four or more species of sportfish. These stations were: White Point, Cabrillo Pier, Santa Monica Bay, Belmont Pier and Orange County Control. A total of 15 additional species were collected, including scorpionfish (*Scorpaena guttata*), rockfish (*Sebastes* sp.), kelp bass (*Paralabrax clathratus*), barracuda (*Sphyraena argentea*), bonito (*Sarda chiliensis*), Pacific mackerel (*Scomber japonicus*), queenfish (*Seriphus politus*), white perch (*Phanerodon furcatus*), black perch (*Embiotoca jacksoni*), halibut (*Paralichthys californicus*), lizardfish (*Synodus lucioceps*), bocaccio (*Sebastes paucispinis*), corbina (*Menticirrhus undulatus*), barred sand bass (*Paralabrax nebulifer*) and flatfish (*Pleuronectidae* sp.).

In order to obtain results that would be representative of what a sportfisherman would catch, this study sampled fish using their methods. In most cases sampling was done by hook-and-line and in some cases, study participants sampled alongside sportfishermen on piers and sportfishing boats. Because the fish needed were not all catchable in the time frame available, some



H-3

samples were taken by trawling. The samples collected by trawl were (1) white croaker from offshore of White Point, (2) 40% of the black perch, white perch, halibut, and queenfish shown as coming from Cabrillo Pier, and (3) all samples except the white croaker from the Belmont Pier. In all cases the fish caught were handled in the same manner as a sportfisherman would treat his catch and were brought back to the laboratory and immediately frozen.

ANALYSIS

From four to forty fish (average of 20) were caught and randomly divided into five composites (when possible) for each species. Edible muscle tissue was dissected from each fish and pooled for each composite under clean laboratory conditions. All samples were kept frozen until analysis. The benzo(a)pyrene samples were kept wrapped in aluminum foil to prevent light from degrading the sample. Each sample was analyzed for the following: percent dry weight by freeze drying, percent lipid weight by chloroform/methanol extraction (Bligh and Dyer 1959), Total DDT and Total PCB by packed-column electron-capture gas chromatography, (Young *et al.*, 1976), and benzo(a)pyrene by high-pressure liquid chromatography using extraction methods of Dunn 1976). Total DDT includes the ortho plus para isomers of DDT, DDE, and DDD; total PCB includes Aroclor 1242 and Aroclor 1254.

RESULTS

White Croaker Survey

Results of the analysis of white croaker for Total DDT, Total PCB, and other physical measurements are listed in Table 1. Mean values at hook and line sportfishing locations ranged from 0.053 mg/wet kg Total DDT and 0.015 mg/wet kg Total PCB in the Malibu/Santa Monica Pier samples to 2.8 mg/wet kg Total DDT and 0.42 mg/wet kg Total PCB in the Gerald Desmond Bridge samples. Higher DDT levels were found in the white croaker trawled from the White Point station. These fish were collected from near the waste outfall to document what is probably the worst possible case: they are not normally caught by sportfishermen.

Table 1. Results of the analysis (n=5) of the edible muscle tissue of white croaker (*Genyonemus lineatus*) collected from the metropolitan Los Angeles area.

					Muscle Tissue					
					%	%	Total DDT mg/wet kg		Total PCB mg/wet kg	
Group[a]	Station	Number Caught	Whole Body Wt. (gm)	Standard Length (mm)	Dry Wet Weight	Lipid Wet Weight	mean ±	1 SD	mean ±	1 SD
[illegible]	White Point[b]	75	118	177	22.[illegible]	1.39	7.3	3.5	0.38	0.11
[illegible]	Gerald Desmond Bridge	24	114	176	20.8	0.92	2.8	2.[illegible]	0.42	0.21
[illegible]	Cabrillo Pier	20	130	[illegible]	[illegible]	1.69	[illegible]	[illegible]	[illegible]	0.05
[illegible]	Malibu/Santa Monica [illegible]	[illegible]	1[illegible]8	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible] Pier	2[illegible]	[illegible]	1[illegible]7	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible] Area	[illegible]	[illegible]	204	20.[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	155	155	[illegible]	1.7[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	14[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	134	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	1[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

[illegible] 1974)

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There were several methods for analyzing the results statistically. First, we compared the Total DDT to the Total PCB median values for all the stations and found that the rankings were significantly similar ($r_s = 0.937$; $p < .001$) indicating a common source for both the Total DDT and Total PCB in white croaker at all stations. Next, we compared the stations and found there were statistically different concentrations of Total DDT and Total PCB between the stations. This indicated that some stations had significantly higher levels of these contaminants than others ($H_{DDT} = 46.54$, $H_{PCB} = 50.40$, DF = 12, $p < .001$). Finally, we compared the results from each station to all the others to determine which stations had similar concentrations. For example, the stations with the highest concentrations that were significantly different from the other stations formed one group. Then the stations with the next highest concentrations formed the next and so on.

The Total DDT values for the thirteen stations were ranked into 6 groups and are presented in Table 1. The trend was similar for Total PCB. White Point and the Gerald Desmond Bridge fell in the group that had the highest levels of Total PCB. Cabrillo Pier, Santa Monica Bay, Venice Pier, Belmont Pier, Marina Del Rey, Navy Mole,and Queen Mary Pier J stations were all in an intermediate group. The two control sites, Orange County and Dana Point were in the group with the Malibu/Santa Monica Pier that had the lowest concentration. The Redondo Area Piers results were between the intermediate group and the group with the lowest concentration.

Intensive Survey

Four stations with elevated concentrations of DDT and PCB measured in the white croaker samples, plus one control station, were resampled for an additional four or more species of sportfish. The stations chosen were White Point, Cabrillo Pier, Santa Monica Bay, Belmont Pier, and Orange County Control. The samples from Cabrillo Pier and Belmont Pier stations were collected at the same location as the white croaker,but the White Point, Santa Monica Bay and Orange County Control stations were sampled from sportfishing boats and varied up to approximately 3 km from the original white croaker sampling stations.

The results of the analysis of the edible muscle tissue for Total DDT (DDE+DDD+DDT) and Total PCB (Aroclor 1242+Aroclor 1254) are listed in Table 2. The mean Total DDT concentrations for all stations combined ranged from 0.036 mg/wet kg in rockfish from the Orange County Control station to 0.76 mg/wet kg in scorpionfish from the White Point station. The mean Total PCB concentrations for all stations combined ranged from 0.011 mg/wet kg in rockfish from the Orange County Control station to 0.16 mg/wet kg in black perch from the Belmont Pier station.

An analysis of variance detected significant differences among stations for the concentrations of both Total DDT and Total PCB ($H_{DDT} = 20.38$, $H_{PCB} = 27.03$; $p < .001$) when all samples were used, including the white croaker results. This indicates that there is a significant increase in the concentration of these contaminants at one or more of the stations over background levels, but it does not indicate what the individual station differences are. Because several species were sampled at more than one station, this allowed us to consider the station differences using those species.

Bonito and Pacific mackerel, both migratory fish, spend a smaller amount of time in any specific area and do not have higher levels of contaminants in samples from contaminated areas than in uncontaminated areas. For fish that may be residents and spend a longer period of time at their respective stations our analyses did detect significant differences among the stations. For the rockfish which were collected from the White Point, Santa Monica Bay, and Orange County Control stations there were significant differences in contaminant concentrations ($H_{DDT} = 10.82$, $H_{PCB} = 12.50$, $p < .005$). Scorpionfish from the White Point station and

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Table 2. Results of the analysis of the edible muscle tissue of sportfish collected from the metropolitan Los Angeles area.

Station	Species	n[a]	Whole Body Wt. (g)	Standard Length (mm)	% Dry/Wet Weight	% Lipid/Wet Weight	Total DDT mg/wet kg mean	± 1 S.D.	Total PCB mg/wet kg mean	± 1 S.D.
White Point	Queenfish	5	246	192	22.6	0.77	0.08	0.03	0.026	0.023
	Rockfish	10	192	180	23.4	0.75	0.14	0.03	0.057	0.015
	Kelp Bass	14	1358	294	30.7	0.98	0.20	0.15	0.042	0.010
	Barracuda	20	2058	398	27.6	1.45	0.10	0.10	0.017	0.011
	Bonito	15	1043	417	29.9	0.85	0.10	0.06	0.022	0.013
	P. Mackerel	25	553	333	28.2	0.76	0.051	0.021	0.014	0.002
Cabrillo Pier	Queenfish	23	89	179	21.7	0.84	0.024	0.008	0.038	0.023
	White Perch	13	75	140	20.6	1.09	0.20	0.08	0.084	0.011
	Black Perch	11	101	142	21.9	1.16	0.16	0.11	0.029	0.013
	Halibut	28	2202	215	22.5	0.91	0.16	0.04	0.052	0.004
Santa Monica Bay	Sheepshead	12	8540	366	20.3	0.85	0.84	0.52	0.16	0.07
	Rockfish	3	1433	277	21.8	0.88	0.044	0.014	0.017	0.006
	Jacksmelt	3	1433	277	21.8	0.88	0.044	0.014	0.017	0.006
	Kelp Bass	1	4300	515	23.3	0.65	0.057	0.037	0.015	0.007
	Barracuda	23	2300	515	23.3	0.65	0.057	0.037	0.015	0.007
	Bonito	20	3450	378	25.8	0.84	0.057	0.037	0.015	0.007
	P. Mackerel	20	845	278	25.8	0.84	0.057	0.037	0.015	0.007
Belmont Pier	Queenfish	14	811	215	19.6	0.85	0.53	0.62	0.15	0.03
	Black Perch	14	1111	192	24.4	1.67	0.24	0.24	0.16	0.09
	White Perch	11	1111	192	24.4	1.67	0.24	0.24	0.16	0.09
	Halibut	11	1111	192	24.4	1.67	0.24	0.24	0.16	0.09
	Spiny Sand Bass	1	1035	415	23.3	0.93	0.077	0.022	0.052	0.018
	Flatfish	1	164	174	23.1	0.93	0.077	0.022	0.052	0.018
Orange County Control	P. Mackerel	25	453	315	22.4	2.78	0.10	0.03	0.078	0.022
	Kelp Bass	10	1211	319	22.5	0.88	0.091	0.052	0.221	0.009
	Barracuda	10	1211	319	22.5	0.88	0.091	0.052	0.221	0.009
	Rockfish	19	113	181	21.1	3.04	0.058	0.011	0.011	0.003

[a] n = the number of composites used in the analysis for Total DDT, Total PCB and BaP.

Santa Monica Bay stations were not significantly different ($U = 15$, $p < .2$), but kelp bass from the White Point station and Orange County Control stations were ($U_{DDT} = 24$, $p < .02$; $U_{PCB} = 25$, $p < .01$). These results indicate that the resident fish from contaminated areas have higher levels of these compounds than fish from uncontaminated areas, while migrant fish from the same location do not show increased levels.

Priority Pollutants in White Croaker

Subsamples were taken from white croaker composites and sent to California Analytical Laboratories in Sacramento for analysis by Gas Chromatography Mass Spectrometry (GC/MS) for all the nonpurgeable EPA priority pollutants (U.S. Environmental Protection Agency 1977). Phenol was the only compound present above the GC/MS detection limit, which for most of the compounds is 25 ug/kg. The concentrations of phenol measured were 42 ug/wet kg in the White Point sample, 96 ug/wet kg in the Santa Monica Bay sample, 100 ug/wet kg in the Belmont Pier sample, 116 ug/wet kg in the Cabrillo Pier sample, and 231 ug/wet kg in the Orange County control. Dioxin was not detected in any samples.

BenzotaiPyrene Results

All samples were analyzed by Robert Arthur of USC for benzotaipyrene (BaP) and in all cases concentrations were below detectable limits of 1 ug wet kg. This was surprising, especially for the Cabrillo Pier station, since levels of 1.7 ± 1.0 ug/wet kg were detected in white croaker muscle tissue from this location in 1979, only two years earlier (Mearns and Young 1979-1980). To insure that the technique was working properly we reanalyzed archived tissue from the 1979 samples and obtained results similar to the 1979 results. As a secondary check we also sampled

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surface water, sediments, and mussels (*Mytilus edulis*) from 9 of the 13 white croaker stations (Table 3). BaP concentrations in the surface water ranged from below detectable limits of 0.001 ug/l at four of the stations to 0.118 ug/l at the Navy Mole station. The sediments ranged from below detectable limits at the Redondo Area Piers station to 18000 ug/dry kg at the Navy Mole, and the mussels ranged from 3 ug/wet kg in the Queen Mary/Pier J sample to 280 ug/wet kg in the Cabrillo Pier sample.

These results indicate that benzo(a)pyrene is present in the environment, especially at the Navy Mole station, at surprisingly high levels. The findings that BaP was not detectable in the edible muscle tissue of fish caught at these stations might be explained by the ability of these fish to metabolize this compound (Stegeman 1981, von Hofe *et al.* 1979).

Cooking

Results of the USC survey indicated that pan frying was the most popular method of cooking by sportfishermen. To determine the effect of pan frying on the contaminant concentrations, white croaker muscle tissue from the Santa Monica Bay and Orange County Control stations were pan fried and then analyzed for DDT, PCB, and BaP levels. Fillets were taken from the opposite side of the fish analyzed for fresh tissue concentrations and fried in 30 mls of Wesson oil at 88°C (190°F) for 4 minutes per side in a Westbend Teflon coated electric skillet (Krone and Iwaoka 1981). The fillets were weighed before and after frying to determine water loss due to the frying. The fillets were then composited in the same manner as the uncooked samples and analyzed for % lipid, DDT, PCB and BaP.

The fried muscle tissue exhibited lower concentrations of chlorinated hydrocarbons than fresh muscle samples. For the Orange County Control samples the average mass of DDT declined 39% to 1.2 ug, and the average mass of PCB declined 29% to 0.18 ug. For the Santa Monica Bay samples the average mass of DDT declined 74% to 2.3 ug and the average mass of PCB declined 65% to 1.1 ug. We were unable to analyze the used cooking oil to determine if the loss in chlorinated hydrocarbons was due to leaching into the cooking oil, but that is a possibility,

Table 3. Concentrations of benzo(a)pyrene (n = 1) determined by Robert Arthur of USC in water (0 - 10 cm below the sea surface), sediment (0 - 2 cm) and whole soft body mussels collected from the metropolitan Los Angeles area. Benzo(a)pyrene was below detectable limits of 1 ug wet kg in all sportfish samples.

Station	Water ug/l	Sediments % Dry Weight	Sediments ug dry kg	Mussels % Dry Weight	Mussels ug wet kg
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

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since the cooking temperature is too low to break down these compounds. BaP was not detected in any of the fried tissue samples, therefore frying fish does not increase the levels of this contaminant either.

DISCUSSION

Edible muscle tissue of sportfish from the metropolitan Los Angeles area contain concentrations of Total DDT and Total PCB that are above background levels. To assess the possible health hazard from eating these fish we determined the daily intake rates of these contaminants based on the white croaker results and the median consumption rates for all species combined for each station (Puffer *et al.* 1981). These results are listed in Table 4 and may be higher than actual intake rates due to the fact that white croaker are not the major portion of fish consumed at every station. The White Point station has been omitted because the consumption rate for that station was computed from surveying people fishing from the shore and our white croaker were taken near the outfall, which is not normally fished. Results of the USC Survey indicated that 10% of the sportfishermen consume as much as 85.2 g/day/person of white croaker. If these fish had been taken at the Gerald Desmond Bridge their daily intake could be as much as 239 ug DDT and 36 ug PCB. There is a group of local sportfishermen who fish for rockfish from the same boat 3-4 times per week in Santa Monica Bay. Everyone on board usually catches their limit of 15 fish which is mainly one species, bocaccio. Assuming they consume approximately 150 g per day, their daily intake rates would be 8.7 ug DDT and 3.0 ug PCB based on our analysis of the bocaccio caught by us from the same boat (Table 2).

The World Health Organization (WHO) recommends that daily intake be no more than 5 ug/kg/day for DDT (U.S. Environmental Protection Agency 1978). If the average man weighs 70 kg, the recommended maximum, safe daily intake would be 350 ug. This level is not reached by any of the stations we surveyed, even in the White Point sample, when you assume an average consumption rate of 36.9 g/day/person, the level only reaches 280 ug. The FDA has a limit of 5 mg/wet kg DDT for the interstate transport of fish. This limit was exceeded by white croaker only from the White Point station. Please note that these guidelines are based on technical grade

Table 4. Estimated daily intake of Total DDT and Total PCB from the consumption of white croaker taken from the metropolitan Los Angeles area.

Station	Median[a] Consumption Rate (g fish/day/person)	Estimated Daily Intake (ug) Total DDT	Total PCB
Gerald Desmond Bridge	20.3	73.6	11.0
C[illegible] Pier	[illegible]	61.7	11.[illegible]
[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	47.7	[illegible]	4.7
[illegible] Pier	32.3	14.5	3.2
Belmont Pier	32.6	1[illegible]	3.4
Redondo Area Piers	[illegible]	14.7	5.[illegible]
[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	36.[illegible]	[illegible]2	0.7
[illegible] Center	[illegible]	[illegible]	0.9
[illegible]	[illegible]	[illegible]	0.[illegible]
[illegible] Pier	40.3	2.[illegible]	

DDT which is 92% DDT, 4.1% DDF, and 0.4% DDD. Our analysis of fish tissue showed the actual percentages of these compounds to be approximately 90% DDE and 10% DDT. DDE is approximately one-eighth as toxic as DDT (National Institute for Occupational Safety and Health, 1979). Therefore, based on the actual quantity of Total DDT found in these fish, none of the samples exceeded the FDA limit.

The concentrations of these trace organic compounds are not sufficiently high to cause acute toxicity. It would take 237 years for a 70 kg fisherman eating 85.2 g/day of white croaker from the White Point station to consume enough DDE to reach the rat LD 50 level (800 mg/kg). However, there is the possibility of sub-acute effects and these results would suggest the need for further research into the uptake rate and metabolism of these contaminants by man. It might be possible to look at the medical histories of the sportfishermen who consume these fish on a regular basis to determine if a specific illness could be attributed to this consumption.

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EKLUND APPENDIX I

OCTC : 1980

SLUDGE MANAGEMENT PROGRAM FOR THE
LOS ANGELES [illegible]

FINAL EIS/EIR

ENVIRONMENTAL IMPACT STATEMENT
ENVIRONMENTAL IMPACT REPORT

LA/OMA PROJECT

United States Environmental Protection Agency

Region IX
215 Fremont St.
San Francisco, CA [illegible]

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ASSESSMENT OF PUBLIC HEALTH CONCERNS ASSOCIATED WITH TRACE ORGANICS IN SEAFOOD

Public health concerns associated with ocean disposal of sewage sludges were evaluated based on use of published data and techniques. The analysis indicates a potentially significant public health concern to sport fishermen from consumption of trace organics in seafood taken from outfall areas. The analysis and conclusions apply principally to existing and past sludge disposal practices. Assumptions used in the analysis may not be applicable to alternative ocean disposal systems such as deep ocean outfalls or barge disposal. The Draft EIS/EIR identified the need for further study of alternative ocean disposal practices to develop more definitive information on probable marine impacts. Along with traditional environmental concerns, such studies should address the potential for the type of public health concerns identified herein and the effect of industrial pretreatment or other approaches to reduce toxicant mass emission rates.

The health effects assessment is based on analysis of trace organics concentrations in sludges and seafoods, seafood consumption patterns of sportfishermen, known information on health effects from DDT and PCB consumption, and consideration of EPA dose-response models, which relates consumption to health effects.

DDT and PCB dosages were estimated based on the concentrations of these constituents in seafood and the seafood consumption rate. A number of conservative assumptions were used in the analysis. Most available data on trace organic concentrations have been determined in fish sampled in the vicinity of the outfalls. Concentrations in fish actually consumed are not known at this time. Therefore, a worst case analysis was conducted assuming concentrations in seafood from outfall areas to be representative of that actually consumed. Also, absolute risk levels were estimated assuming lifetime exposure to constant dosages of DDT or PCB which resulted in part in the conclusions regarding public health concerns. Less conservative assumptions would result in lower risk estimates. Further study is needed to verify assumptions used in the analysis and to further refine health risks associated with shoreline and offshore fishing activities.

Specific conclusions of the analysis are as follows.

- While a large number of potentially toxic organic compounds may be present in sewage sludges, DDT and PCB compounds appear to be of most concern due to their relatively higher concentrations compared to other trace organics, environmental persistence, and potential for bioaccumulation.

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- Concentrations of DDT and PCB in LA/OMA sludges have generally decreased in the last decade. However, concentrations in sludges have remained relatively constant in more recent years. Industrial or commercial sources of the remaining toxicants have not been identified. While use of DDT and PCB is being curtailed in the United States, it is not known whether significant decreases in sludge DDT and PCB concentrations will result in the near future.

- PCB concentrations in edible tissues of fish from control areas are generally in the range of a few hundredths of a ppm(ug/gm). Concentrations are higher around the outfall areas, ranging from tenths to more than one ppm.

- DDT concentrations in edible fish tissues were similar for control areas, the CLA 7-mile outfall area, and the OCSD outfall area, generally in the range of a few tenths of a ppm or less. However, for the LACSD outfall at Whites Point, seafood concentrations are in the ppm range and have exceeded 10 ppm in several measurements. It is likely that seafood concentrations at Whites Point are significantly affected by historical high discharges of DDT. Prior to 1971, an estimated 500 lbs/day of DDT were discharged. Source control measures begun in 1970 have reduced the mass emission rate to about 7 lbs/day. Recent data suggest a downward trend in DDT concentrations in flatfish. However, present seafood concentrations may be related to historic and present discharges of DDT. The contribution of each DDT source to present seafood concentrations is not clearly established and further monitoring is needed.

- Preliminary studies by the University of Southern California have documented the existence of a regular fishing population along the Southern California shoreline, even at sites likely to be influenced by waste discharge. A majority of the 562 cases surveyed to date consumed fish 1-4 times a week or more. Fish caught are generally shared with family members. White croaker is the most frequent catch and has been observed to bioaccumulate both PCB and DDT in edible tissues in samples from outfall areas.

- Preliminary seafood consumption rates were projected by the USC study based on survey data. The median consumption rate was estimated to be 36 gm/day with a 90 percentile value of 284 gm/day (i.e. 10% of cases consumed more than 284 gm/day). The mean consumption rate was 92 gms/day. Average consumption for the U.S. population as a whole has been estimated at about 18.7 gm/day.

- Recent animal feeding studies by FDA have shown an association between PCB exposure and serious subchronic and chronic toxicities, including adverse reproductive effects, tumor production, and possibly carcinogenicity. The FDA concluded that human exposure to PCB's should be reduced. DDT is a suspected carcinogen and has induced liver tumor in rats, although available data are limited.

- FDA limits for DDT and PCB in edible fish tissues are both 5 ppm wet weight. A PCB tolerance limit of 2 ppm has been proposed. However, the FDA has indicated that the proposed 2 ppm tolerance would not protect sports fishermen and others who consume abnormally large amounts of highly con-

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taminated species and that it is important as a matter of public health protection to minimize human exposure to PCB. Analysis of FDA source documents infers that an average consumption of about 50 gm/day or more would be considered abnormally large.

- Cancer risk models for PCB and DDT have been developed by the Carcinogen Assessment Group (CAG) of the Office of Research and Development of the EPA based on data from animal feeding studies. Risk assessment models can provide quantitative estimates of risks associated with different levels of exposure. However, calculated risks should be understood to represent order of magnitude estimates and not precisely defined numerical values.

- Cancer risk for DDT and PCB, as determined by the CAG models, is proportional to the dosage of these toxicants.

- The dosage of DDT and PCB from seafood depends on the concentration of these constituents in seafood and the quantity of seafood consumed.

- DDT and PCB concentrations in fish actually consumed by shoreline or sportsfishermen is not known at this time. A worst case analysis was conducted assuming concentrations in seafood from outfall areas to be representative of that actually consumed.

- Using assumed representative tissue concentrations based on available data, consumption of seafood from control areas, even at high consumption rates, would appear to present risks from PCB and DDT which are less than or equal to that associated with the present average U.S. dietary intake. However, the health risk for the average U.S. dietary intake of PCB and DDT is itself projected to exceed recommended limits used for establishing water quality criteria.

- USING assumed representative tissue concentrations based on available data, consumption of seafood from the three outfall areas would present an elevated risk due to higher PCB concentrations; about twice the U.S. average risk for the median consumption case (35 gm/day), and about 16 times for the 90 percentile consumption case (284 gm/day). Consumption of seafood from an outfall area poses about a 20 times greater risk from PCB than consumption of an equivalent quantity of fish from a control area.

- Seafood concentrations of PCB from the LA/OMA outfall areas, while elevated above control samples from the Southern California Bight, may not be higher and may in fact be less than concentrations observed in freshwater fish from other contaminated areas.

- Using assumed representative tissue concentrations based on available data, consumption of seafood from the Whites Point area would present an elevated risk due to high DDT concentrations; about 23 times the U.S. average risk for the median consumption case, and about 180 times for the 90 percentile consumption case. Consumption of seafood from the Whites Point area poses about a 170 times greater risk from DDT than consumption of an equivalent quantity of fish from a control area. The DDT health risk from consumption of seafood from the OLA and OCSD outfall areas would not be significantly

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different from the control case because DDT concentrations are not substantially elevated compared to the control.

- The potential exists for ingestion of unusually large dosages of DDT or PCB resulting from consumption of a small number of highly contaminated fish. Consumption of only 500 gms of seafood contaminated with 8 ppm PCB and 176 ppm DDT, the upper range of observed values at Whites Point, would result in a single dosage equivalent to that projected from the U.S. average diet for a period of 1.2 years in the case of PCB and 30 years in the case of DDT.

- The analysis indicates a potential public health concern to consumers of trace organics in seafood taken from outfall areas.

- Further studies are needed to refine the relative health risks associated with shoreline and offshore fishing activities. Analysis of DDT and PCB concentrations in fish samples collected as part of the USC Fish Usage Survey will be most useful in this regard, but may not of itself be sufficinet to fully document the extent of the concern.

- If additional data and studies support the findings of this analysis, a number of approaches are available to reduce the potential public health concern including: (1) advisories to fishermen to avoid high consumption of certain species of fish from affected areas, and (2) closure of beaches and/or outfall areas to seafood gathering in cases where high contamination levels present an excessive public health risk.

INTRODUCTION

Trace organics, especially DDT and PCB are expected to be present in trace concentrations in LA/OMA sludges for at least the near future. Ocean disposal of sludge has been observed to result in bioaccumulation of the organic toxicants in seafood organisms. Harvesting of effected organisms by commercial or sportsfishing activities and subsequent consumption can lead to the entry of trace organics into the human food chain.

A discussion of public health concerns associated with trace organics in seafood resulting from sludge disposal in the ocean was presented in the DEIS/DEIR (pp. VI-67 to VI-70). The analysis was limited due to constraints of time and data availability. However, it was concluded that "Cancer risk models... indicate a potentially significant public health concern with regard to trace organics in seafood taken from outfall areas." Due to the preliminary nature of the analysis it was further concluded that due to "the potential concern and degree of uncertainty associated with the (cancer risk) models, further examination of the potential health risks is desirable and will be undertaken during the review of the DEIS/DEIR."

In April 1980, the LA/OMA Project Policy Board directed Project staff "to respond to changes in published EPA cancer risk models during the time available prior to completion of the final EIS/EIR with a view towards reporting quantitative estimates of risk in the final EIS/EIR" (Ref. 9).

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Based on the above directives, the public health assessment of trace organics in seafood from sludge disposal in the ocean was extentively reviewed. Additional information was developed in the following areas: (1) improved documentation of trace organic levels in seafood organisms around the outfall areas; (2) estimates of catch consumption by sports fisherman based on information from a University of Southern California Fish Usage Survey; (3) additional information on the revised EPA cancer risk models for DDT and PCB. Purpose of this chapter is to present this new information and the results of the analysis of public health risks associated with ocean disposal of sludge.

TRACE ORGANICS IN SLUDGE

Trace organic compounds of environmental concern are usually present in municipal sludges in low concentrations. The term trace organic is generally used in reference to organic compounds which exhibit toxicity at low concentrations. Such compounds are usually synthetic, persistant in the environment, oftentimes halogentated, generally not essential for biological metabolism, and often have the potential to bioaccumulate particularly in the aquatic environment. The principal trace organics present in LA/OMA area sludges include DDT and its metabolites, various forms of PCB, and chlorobenzenes. Other pesticides are occasionally found in lower concentrations including lindane, heptachlor, aldrin, dieldrin, and endrin. This analysis focuses on the effects of DDT and PCB compounds because they are the principal trace organics present in LA/OMA sludges, they are environmentally persistant and health effect models are available for each.

The historic trend of DDT and PCB inputs in sewage and concentrations in digested sludge from the LA/OMA agencies are presented in Table 1. Major discharges of DDT into the LACSD system were discontinued in 1971 and mass inputs have decreased by more than an order of magnitude from those of the early 70's. However the DDT mass input has remained relatively constant at about 6 lb/day since 1975. Mass inputs of DDT to the CLA and OCSD treatment facilities appear to be significantly less than for the LACSD system, although little data is available in the case of OCSD.

PCB mass inputs to the LACSD system have declined steadily from the early 70's. However, concentrations in sludge appear to have leveled off in recent years. For the CLA, sludge concentrations have remained relatively constant for a number of years. Unlike DDT, PCB appears to be present in all LA/OMA sludges in approximately equivalent concentrations. Again, only limited data is available for OCSD sludges.

Historically, principal uses of PCB were in electrical devices such as transformers and capacitors, as hydraulic fluid and in micro coating of carbonless copy paper. LACSD reported on the monitoring of several suspected sources of PCB discharge (Ref. 10). In 1976, it was found that the major sources were from paper companies recycling waste office paper. However, since 1973, only insignificant amounts of PCB have been found in these discharges. The City of Los Angeles also reported no known industrial or commercial discharges of DDT or PCB to their sewer system (Ref. 11). Therefore, the present inputs appear to be background in nature and significant decreases in sludge concentrations are not expected in the near future. Sludge disposal in the ocean would continue to introduce low levels of trace organics to the marine environment.

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TABLE 1

TRACE ORGANICS IN SLUDGE FROM LA/OMA OPERATING AGENCIES

SLUDGE TRACE ORGANICS	CLA		LACSD		OCSD	
	TICH(1)	PCB	DDT	PCB	DDT	PCB
INPUTS IN SEWAGE, lb/day						
Sampling Frequency	Monthly		Weekly			
1971	-	-	105	60.1	(Data Not Available)	
1972	-	-	45	28.0		
1973	13.12	-	22.8	15.0		
1974	5.05	-	11.5	63.8(2)		
1975	6.58	-	4.92	12.0		
1976	9.01	-	6.07	7.09	0.3*	3.2*
1977	4.10	4.5	5.93	7.66		
1978	4.90	3.75	6.85	2.70**		
1979	4.45	4.07	6.58	3.37		
DIGESTED PRIMARY SLUDGE CHARACTERISTICS, mg/dry Kg						
Sampling Frequency	Monthly		Monthly			
1971	4.10	2.93			(Data not Available)	
1972	9.43	8.10				
1973	3.88	2.98				
1974	0.87	0.39	17			
1975	3.01	1.88	9	15		
1976	1.98	0.77	9	8	0.14	6.0
1977	2.21	-	10	9		
1978	1.56	1.11	11	3		
1979	1.54	1.32	4**	1.7**		

*Estimated
**7 months' data
(1) TICH = Total Identifiable Chlorinated Hydrocarbon, including mainly the sums of DDT and PCB values.
(2) PCB data reported before 1974 may not be reliable due to development of lab procedure.

TRACE ORGANIC CONCENTRATIONS IN SEAFOOD ORGANISMS

Bioaccumulation of trace organics in seafood organisms taken around outfall locations has been reported. A summary of measured DDT and PCB concentrations in representative fish and invertebrates caught in a control area, near the LACSD effluent outfall at Whites Point, near the CLA 7-mile sludge outfall, and near the OCSD effluent outfall is shown in Table 2. The data shown in the table have been derived from various sources and appear indicative of differences among the respective areas. Elevated concentrations of PCB are generally observed in species caught near the outfall areas compared to control stations near Catalina Island and Dana Point. An increase in DDT is particularly evident in species caught near the LACSD outfall due in large part to previous discharges of DDT which left a considerable stock in bottom sediments.

The PCB concentration in edible tissues of fish from the control areas are in the range of a few hundredths of a ppm. Concentrations are higher around the outfall areas, ranging from tenths to more than one ppm. In general, water column fish like rockfish have much less PCB concentration than bottom dwelling fish like dover sole and sanddab. White croaker, a frequent catch of shoreline and private boat fishermen alike, was found to contain quite high concentrations of PCB from the limited samples available. Filter feeding invertebrates were also found to have concentrations one to two orders of magnitude higher than the control.

DDT concentrations in edible fish tissues are similar for the control areas, the City of Los Angeles 7-mile outfall area and the OCSD outfall area, generally in the range of a few tenths of a ppm or less. However, for the LACSD outfall area at Whites Point, fish concentrations are reported in the ppm range. Median concentrations for white croaker and dover sole were over 10 ppm. Invertebrates seafood organisms at the Whites Point area also show one to two orders of magnitude higher concentrations than the control.

While use of DDT and PCB is being curtailed in the United States, it is not known whether significant decreases in sludge DDT and PCB concentrations will result in the near future. Therefore, PCB concentrations in seafood near the outfall areas may not change significantly from values in Table 2, at least in the near term. In the case of DDT, the accumulated stock in bottom sediments at White's Point will result in elevated seafood concentrations for the forseeable future. The potential for exposure of subsurface sediments high in DDT in the White's Point area has been suggested following termination of sludge disposal by LACSD (Ref. 12). Historic discharge of high DDT solids have been buried to some extent by more recent solids discharges with greatly reduced DDT concentrations. Exposure of the older sediments is possible upon termination of the solids discharge and could result in increased environmental exposure to DDT compared to present levels. The effect would be temporary, however, since the same forces of erosion should eventually carry away the high DDT sediments.

It is important to note that trace quantities of PCB are found in many marine and freshwater fish, not just those under the influence of a marine outfall. The FDA reported on PCB concentrations for a large number of freshwater fish, covering numerous species obtained from over 100 locations nationwide (Ref. 13). Contamination appeared to be geographically widespread, although in many greater highest concentrations occur in the Great Lakes and in major rivers in the East

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TABLE 2

TRACE ORGANICS CONCENTRATIONS IN EDIBLE TISSUES OF SEAFOOD ORGANISMS AROUND OUTFALL DISCHARGE ZONES

(All concentrations in ug/gm wet weight)

SEAFOOD ORGANISMS	ISLAND/COASTAL CONTROL		LACSD		CITY OF LOS ANGELES (7-MILE OUTFALL)		OCSD	
	DDT	PCB	DDT	PCB	DDT	PCB	DDT	PCB
Black Perch								
Median	0.014	-	3.2	-	-	-	-	-
Range	0.01-0.02		1-9					
n, (Yr.)	4 (1974-75)		25 (1975-77)					
Reference	4		4					
White Croaker								
Median	-	-	11.10	1.05	-	-	0.05	0.06
Range			5.7-176	0.3-10			0.02-0.07	0.04-0.12
n, (Yr.)			10(1975-77)				3(1978-79)	
Reference							3	
Pacific Bonito								
Median	1.03	0.5	1.00	0.03	-	-	-	-
Range	0.04-1.9	0.16-0.52	0.3-1.2	0.13-0.49				
n, (Yr.)	3(1975-77)		3(1975-77)					
Reference	1		1					
Queenfish								
Median	-	-	3.2	0.86	-	-	-	-
Range			1.0-5.7	0.46-1.56				
n, (Yr.)			6(1975-77)					
Reference			1					
Pacific Mackerel								
Median	-	-	-	-	-	-	0.05	0.09
Range							-	-
n, (Yr.)							(1978)	
Reference							3	
Rock Fish								
Median	-	-	0.61	0.11	-	-	0.03	0.08
Range			0.25-4.0	0.08-0.38			0.01-0.11	0.03-0.30
n, (Yr.)			7(1975-77)				9(1977-79)	
Reference			1				3	

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TABLE 2 (CONTINUED)

TRACE ORGANICS CONCENTRATIONS IN EDIBLE TISSUES OF SEAFOOD ORGANISMS AROUND OUTFALL DISCHARGE ZONES

(All concentrations in ug/gm wet weight)

SEAFOOD ORGANISMS	ISLAND/COASTAL CONTROL		LACSD		CITY OF LOS ANGELES (7-MILE OUTFALL)		OCSD	
	DDT	PCB	DDT	PCB	DDT	PCB	DDT	PCB
Median			2.22	0.07				
Range			-	-				
n, (Yr.)			Composite of 10 (1980)					
Reference			6					
English Sole								
Median	-	-	-	-	-	-	0.12	0.33
Range							0.03-0.63	0.02-1.2
n, (Yr.)							11(1975-78)	
Reference							3	
Halibut								
Median	-	-	-	-	-	-	0.02	0.05
Range							0.004-0.19	0.006-0.22
n, (Yr.)							8(1974-76)	
Reference							3	
Horny Head Turbot								
Median	-	-	-	-	-	-	0.06	0.08
Range							0.01-0.36	0.025-0.86
n, (Yr.)							11(1974-78)	
Reference							3	
California Lizardfish								
Median	-	-	-	-	-	-	0.02	0.03
Range							0.006-0.04	0.01-0.04
n, (Yr.)							2(1978)	
Reference							3	
Sea Urchin (Gonads)								
Median	-	-	4.5	0.61	-	-	-	-
Range			0.45-15.6	0.1-6.0				
n, (Yr.)			25(1977)					
Reference			7					
Mussel								
Median	0.02	0.03	0.28	0.24	-	-	-	-
Range	0.01-0.03	0.02-0.04	0.25-0.3	0.23-0.25				
n, (Yr.),	-(1977-78)		-(1977-78)					
Reference	8		8					

TABLE 2 (CONTINUED)

TRACE ORGANICS CONCENTRATIONS IN EDIBLE TISSUES OF SEAFOOD ORGANISMS AROUND OUTFALL DISCHARGE ZONES

(All concentrations in ug/gm wet weight)

SEAFOOD ORGANISMS	ISLAND/COASTAL CONTROL		LACSD		CITY OF LOS ANGELES (7-MILE OUTFALL)		OCSD	
	DDT	PCB	DDT	PCB	DDT	PCB	DDT	PCB
Bass								
Median	0.025	0.023	1.56	0.21	-	-	0.05	0.17
Range	0.01-0.06	0.022-0.054	0.4-2.4	0.12-0.76			0.03-0.08	0.05-0.28
n, (Yr.)	3(1975-77)		6(1975-77)				2(1978-79)	
Reference	1		1				3	
Median	0.11	-	3.4	-				
Range	0.03-0.29		0.07-67					
n, (Yr.)	12(1971-75)		10(1977)					
Reference	4		4					
Scorpion Fish								
Median	0.11	0.57	3.51	0.45	-	-	0.04	0.09
Range	0.03-0.15	0.01-0.063	2.0-5.2	0.40-0.98			0.01-0.08	0.07-0.16
n, (Yr.)	3(1975-77)		4(1975-77)				4(1975-77)	
Reference	1		1				3	
Sable Fish								
Median	-	-	5.23	0.23	0.19	0.19	-	-
Range			1.8-12.9	0.09-0.65	0.16-0.23	0.10-0.27		
n, (Yr.)			6(1975-77)		6(1978)			
Reference			1		1			
Dover Sole								
Median	0.1	0.05	16.69	1.31	0.16	0.46	0.34	0.54
Range	-	0.03-0.07	1.0-101	0.04-7.9	0.07-0.39	0.12-1.56	-	-
n, (Yr.)	1(1974-75)	-(1974-75)	44(1975-77)		12(1979)		1(1979)	
Reference	5		1		2		3	
Median			3.05	0.12				
Range			0.35-10.2	0.02-0.26				
n, (Yr.)			10(1980)					
Reference			6					
Sanddab								
Median	0.16	0.022	6.10	0.46	0.09	0.11	0.03	0.06
Range	0.06-0.43	ND*-0.05	3.1-11.2	0.28-1.1	0.04-0.21	0.06-0.18	0.004-0.17	ND-0.7
n, (Yr.)	10(1975-77)		13(1975-77)		6(1978)		53(1974-76)	
Reference	1		1		2		3	

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TABLE 2 (CONTINUED)

TRACE ORGANICS CONCENTRATIONS IN EDIBLE TISSUES OF SEAFOOD ORGANISMS AROUND OUTFALL DISCHARGE ZONES

(All concentrations fn ug/gm wet weight)

SEAFOOD ORGANISMS	ISLAND/COASTAL CONTROL		LACSD		CITY OF LOS ANGELES (7-MILE OUTFALL)		OCSD	
	DDT	PCB	DDT	PCB	DDT	PCB	DDT	PCB
Rock Scallop								
Median	0.02	0.004	0.16	0.014	-	-	-	-
Range	ND-0.18	ND-0.01	0.10-0.22	0.008-0.02				
n, (Yr.)	10(1975-77)		9(1975-77)					
Reference	1		1					

*ND = Non-Distinguishable with blank.

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and the Mississippi basin. Some Great Lakes' species, mainly coho salmon and lake trout, show PCB levels ranging as high as 30 ppm, while Hudson River species range as high as 178 ppm. Therefore, seafood concentrations of PCB from the LA/OMA outfall areas, while elevated above control samples from the Southern California Bight, may not be higher or may in fact be less, than concentrations observed in freshwater fish from other contaminated areas.

SEAFOOD CONSUMPTION PATTERNS

The importance of the Southern California Bight as a location for both commercial and sport fishing is well documented. Commercial fish landings are concentrated near urban areas. Most of the commercial fish and shellfish catch (by weight) is taken from San Pedro Channel within 10 to 30 km of the Los Angeles and Orange County municipal discharges. (Ref. 14.) Areas near deep water municipal and thermal outfalls are also frequently fished by commercial party boats, private fishermen and scuba divers (Ref. 15). It has been reported that scallops near the Los Angeles County outfall are sought by divers (Ref. 16). Data indicate that in 1973, nearly half of the coastal catch (one third of the entire catch of the Southern California Bight) was taken within 20 km of the largest municipal outfalls. Areas near outfalls appear to receive at least 10 times more fishing pressure than the coastal area as a whole. (Ref. 15.)

It is difficult to quantify the importance of shellfishing. However, considerable commercial and recreational shellfishing actively occurs in the rocky intertidal and subtidal areas along Palos Verdes Peninsula. Due to its varied intertidal habitats, Palos Verdes offers a wider variety of shellfish than other beach areas (e.g. Huntington, Santa Monica, Laguna, and Malibu) (Ref. 17.).

Over the past few years a substantial commercial sea urchin fishery has been established in Southern California. From its initiation in the late 1960's, statewide landings reached over 7 million pounds by 1975. By far the largest quantity came from the Santa Barbara Area, especially the offshore northern Channel Islands. The Palos Verdes shelf region contribution increased from an estimated 14,000 in 1960 to 44,000 pounds in 1975, some 2 to 6 percent (respectively) of the statewide total. Only gonads are prepared for human consumption which represents somewhat less than 10 percent of the fresh, wet weight of the sea urchin. (Ref. 17.)

Some limitations are imposed against seafood harvesting in criteria portions of the Southern California Bight. There is a statutory prohibition against trawling within the State three-mile limit except for a selected area above Ventura. For the case of Santa Monica Bay, the three-mile limit was drawn diagonally from Palos Verdes to Malibu, effectively cutting off trawl fishing in most of the Santa Monica Bay (Ref. 18). Moreover, Section 41.54 of the City of Los Angeles' Municipal Code also forbids fishing within one mile of the diffuser outlets. However, it is unknown whether the one-mile limit is adequate or whether it has been enforced.

An important link in the public health risk assessment is the determination of the potential for consumption of fish with elevated concentrations of DDT and PCB. Two recent studies have refined further the status of sportsfishing activities in the Southern California area and the findings are discussed below.

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UNIVERSITY OF SOUTHERN CALIFORNIA FISH USAGE STUDY

A Fish Usage Study is being conducted by the USC Medical School under the direction of Dr. Harold Puffer. Purpose of the study is to document and characterize sportsfishermen and their catches in the shoreline areas of Los Angeles and Orange Counties. The coastline from Santa Monica south around Palos Verdes to Belmont was divided into 11 statistical zones. A questionnaire survey approach was used. Both fishing information and catch statisitcs, as well as personal biographical data of the fishermen is being documented.

Based on data collected from January 5 to May 30, 1980, a total of 149 site visits were made to the 11 zones (Ref. 19). A total of 562 interviews were conducted among the total fisning population present of 6324. The 562 fishermen interviewed claimed to represent 1589 total family consumers of fish. About 40% of the interviewed population were caucasian, 25% Black, 17% Mexican-American, and 12% Oriental/Samoan, with 6% other. 52% of the cases consumed caught fish 1-4 times a week; most cases (98%) have at least one adult fish eater in the family; 79% of the children in the family of the cases are fish eaters. White croaker is the most frequently caught fish and pan frying is the favorite method of cooking. Three species of fish dominate both the number and weight caught: White croaker, bonito and Pacific mackerel.

To compute the mean consumption of each type of fish, the USC group made the following assumptions for each case interviewed: (1) the amount of fish and average weight of fish per catch is constant; (2) the frequency of fishing is constant throughout the year; (3) the number of family fish-eaters is constant and the catch is shared evenly among family members; (4) all of the catch is eaten and half the weight of fish is edible. The average weight of three fish selected randomly among a given species and the number of fish caught for that species were used to determine the weight of catch for that species. The weights caught for all species were used to determine the total weight caught.

Based on the above assumptions, average consumption rates for the cases interviewed were calculated and ranked. The median consumption rate was found to be 36 gm/day and the 90 percentile value 284 gm/day (i.e. 10% of cases consumed more than the stated value). The mean consumption rate was 92 gm/day. By way of comparison the average fish consumption for the U.S. population as a whole has been estimated at about 18.7 gm/day (Ref. 20). Thus, shoreline fishermen tend to consume fish at rates considerably above the national average. Ten percent of the cases interviewed are estimated to consume more than 15 times the national average.

Results from the USC Study are preliminary and continued surveys are being conducted, especially for the summer fishing season. However, a number of preliminary conclusions appear evident from the results to date. There exists a regular fishing population along the Southern California shoreline, even at sites likely to be influenced by waste discharges. Fish caught are generally shared with family members and consumed. The consumption rate of fish is projected to be considerably higher than the national average. Fish caught are dominated by only a few species. Among these, white croaker and Pacific bonito have been found to accumulate trace organics. Data for Pacific mackerel are very limited, and the degree of accumulation cannot be determined at present

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DEPARTMENT OF FISH & GAME SPORT FISHING SURVEY

The Department of Fish and Game has conducted Sport Fishing Surveys of private and party boat fishermen and recreational divers (Ref. 21). Purpose of these surveys is to estimate effort levels expended by anglers and divers, the magnitude and composition of their catch, and to assess the degree of compliance with size limit regulations. 31 locations around the Southern California coast were sampled in 1977-78, from Gaviota in Ventura to Mission Bay in San Diego. A total of 11 locations from Paradise Cove to Art's landing near Newport are in the LA/OMA area. Catch statistics for the latter stations are given in Table 3.

Based on about 50 sampling days, a total of 160,500 anglers was recorded, with the number of fish landed at almost 400,000. White croaker, Pacific mackerel and rockfish dominated the catch, with over 50 percent of the total number. The number of divers counted in the Los Angeles and Orange County area for the 50 sampling dates was about 4000. Majority of the catch was rock scallop, spiny lobster and abalone.

It is apparent that there exists a substantial population of offshore fishermen. The anglers and their families would be the potential population for exposure to the effects of sludge discharge from consumption of their seafood catches. The types of fish caught are similar to those caught by the shoreline fisherman. White croaker, the most frequent catch, has been found to accumulate trace organics in samples from the vicinity of the outfall areas.

No data on offshore fishing locations or the levels of trace organics in the fish caught are available. However, it would not be surprising that some anglers would fish in the vicinity of the outfalls on occasion. Estimates of consumption rates cannot be made from the available data. However, above average consumption of fish would be expected.

HEALTH EFFECTS OF TRACE ORGANIC CONSUMPTION

Human health effects of DDT and PCB are summarized in Table 4. Average U.S. intake figures are about 8 ug/day for DDT (1973) and 9 ug/day for PCB (1975). DDT intake has dropped dramatically in recent years from about 63 ug/day in 1965 (Ref. 22). PCB intake also has decreased slightly from about 15 ug/day in the late 60's (Ref. 23).

DDT does not appear to result in major clinical effects as a result of chronic exposure. It is not mutagenic nor teratogenic. However, it is a suspected carcinogen and has induced liver tumor in rats, although available data are limited.

The health effect of PCB consumption is based in part on studies of Japanese "Yusho" patients who ingested rice oil contaminated by PCB. Patients were exposed to high doses and showed acute toxic effects from the exposure. However, subsequent research found that the PCB itself was also contaminated by other more toxic compounds such as chlorinated dibenzofurans. Therefore, the Yusho patient study on the adverse health effect of PCB appeared inconclusive. Recently, animal feeding studies were conducted with PCB. The Food & Drug Administration (FDA) summarized the new information as follows (Ref. 25): "The

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TABLE 3

CATCH STATISTICS FROM CALIFORNIA DEPT. OF FISH AND GAME
INDEPENDENT SPORT FISHING SURVEY
LOS ANGELES AND ORANGE COUNTIES, JULY 1977 TO JUNE 1978

SPORT ANGLER		
Sampling Days	50	
Angler Party	61,000	
Anglers	160,500	
Angler-Trip-Hour	1,000,000	
FISH CATCH		
Total No.	396,000	
White Croaker	120,000	(30%)
Pacific Mackerel	57,000	(14%)
Rockfish spp.	50,600	(13%)
Bass spp.	37,000	(9%)
Pacific Bonito	12,000	(3%)
SPORT DIVER		
Sampling Days	50	
Diver	3,750	
ORGANISM CATCH		
Total No.	14,000	
Rock Scallop	4,800	
Spiny Lobster	1,200	
Abalone	1,100	
Kelp bass	800	
Calif. Sheephead	700	

Data Source:

Wine, V., 1979, Southern California Independent Sport Fishing Survey, Annual Report No. 3, July 1, 1977 to June 30, 1978", Marine Resources Region, Administrative Report No. 79-3, January, Appendix III & IV.

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TABLE 4

HUMAN HEALTH EFFECT OF DDT AND PCB(1)

	DDT	PCB
Present (1973) U.S. Intake, ug/day	8 (1973)	9 (1975)
Dietary Intake at Lifetime Cancer Risk Level of 10^{-5} ug/day(3)	0.08(2)	0.17
General Physiological Effects at low level chronic exposure	No apparent ill effect except for bioaccumulation in fatty tissues and blood	Dermal, Mucosal and Internal Disturbance; Bioaccumulation in fatty tissues
Teratogenicity	No	Adverse reproductive effects to maternal monkey and toxic effects to nursing offspring.
Carcinogenicity	Suspected Carcinogen (Liver tumor in animals)	Liver tumor in rats, Pigment Cell cancer and tumor in Japanese Yusho patients.
Multi-stage model Potency Factor, Q_1^*(4) (Risk per mg/day average lifetime intake per kg body weight)	8.4	4.3

1. U.S.E.P.A. "Preliminary Water Quality Criteria - DDT and PCB", October 1977, (NTIS 297 923 and 296 803 respectively.)
2. An "Acceptable Daily Intake" of 5 ug/day/kg or 350 ug/day for a 70 kg man was given by World Health Organization, Residual Review, 56 : 107 (1975).
3. Calculated Intake (ug/day) = Risk level (10^{-5}) x $\frac{1 \text{ ug}}{10^{-3} \text{ mg}}$ x 70 kg x $\frac{\text{mg/Kg/day}}{Q_1^*}$
4. Q_1^* is the carcinogenic potency factor based on a multi-stage dose extrapolation model used to estimate lifetime cancer risks in humans.

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new toxicity data consists primarily of animal studies showing an association between PCB exposure and serious subchronic and chronic toxicities, including adverse reproductive effects, tumor production, and possibly, carcinogenicity, as well as effects on numerous biochemical systems.... Although the data do not fully resolve such important questions as the carcinogenicity of PCB's, they lead to the conclusion that neither "no effect" nor "allowable daily intake" levels for PCB's can be established with any confidence and that, from a toxicological point of view, human exposure to PCB's should be reduced."

Besides the suspected carcinogenic effect of PCB, the FDA is concerned with adverse health effects to pregnant and lactating women and their offspring. Ingested PCB has been found to concentrate in breast milk. In a recent nationwide survey (Ref. 25) consisting of 1,033 samples of human breast milk collected in 44 states, the mean concentration of PCB's was estimated to be about 1.00 to 1.10 ppm (on a fat basis). Although data are limited, it is reasonable to assume that among women who consume above-average amounts of PCB-contaminated fish, or are exposed to PCB from other sources, the levels of PCB in breast milk will be significantly higher.

The health effect to a nursing infant from consumption of PCB in human breast milk has not been determined, pending results from ongoing epidemiological studies. However, the FDA has reported that the link between PCB exposure and adverse reproductive effects in the rhesus monkey has been established more clearly from recent data (Ref. 25). Earlier data showing acute toxic effects in the nursing offspring of PCB-exposed maternal monkeys have also been confirmed.

Recently, human epidemiological studies were undertaken at the EPA Large Lake Research Station in Grosse Ile, Michigan. In an adult exposure study of 300 fish eaters who consume more than 6 lbs. of fish a year, the data seemed to shown "A regressive type of relationship between the serum level of PCB and the amount of fish consumed. Observations indicated that the pulmonary system of consumers may be affected. These facts, though, have not been confirmed by epidemiologic research.... Additional studies are being performed on 100-200 newborns whose mother was exposed to PCBs and PBBs. Serum levels of PCBs and PBBs are taken and the Brazelton scale of Infant Development is used to evaluate the growth of the child. There seems to be an inverse relationship between the Brazelton score and the level of PCB and PBB in the serum of the mother." (Ref. 30)

FDA LIMITS FOR DDT AND PCB

The FDA limits for DDT and PCB concentrations in edible fish tissues used in interstate commerce are both 5 ppm (wet weight). The PCB tolerance level was lowered to 2 ppm in July 1979 (Ref. 11), but was subsequently stayed by an objection and request for hearing filed by the National Fisheries Institute, Inc. in October 1979 (Ref. 26).

There is no published document on the rationale behind the setting of the DDT action level in fish (Ref. 27). However, extensive documentation for the proposed change in PCB tolerance levels in fish and other foodstuffs were published in 1977 and 1979 (Ref. 13, 25). FDA is authorized "to promulgate regulations limiting the quantity of... unavoidable substances that can be present legally in food. Such limits, called tolerances, are to be set by FDA at the level

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found necessary to protect the public health, taking into account the extent to which the substance is... unavoidable and the other ways the consumer may be affected by the same or other poisonous or deleterious substances." (Ref. 25).

Unlike the EPA Water Quality Criteria, the FDA tolerance limits are set with other factors besides protection of public health taken into consideration, although public health protection is of paramount concern. For the case of PCB, the proposed limit of 2 ppm in fish was arrived at based in part on enforcement and economic considerations. It was determined by FDA that 1 ppm is the level that can be reliably measured for enforcement purposes by available analytic methods. (Ref. 11). It was also the judgement of the Agency that the "2 ppm tolerance effects a meaningful decrease in the risk to consumers while still excluding from commerce only a relatively small amount of food (about $5.7 million landed valued in 1974 dollars)." (Ref. 25).

However, FDA did recognize the importance in reducing the intake of PCB from fish. "Indeed the new data show that fish are the only food group in which detectable level of PCB contamination is routinely found" (Ref. 25). It was emphasized that "the toxicological data available of PCB's makes it clear that, in an ideal situation, it would be preferable not to have PCB's in food at any level." (Ref. 25). The Agency concluded that "it is important as a matter of public health protection to minimize human exposure to PCB's" (Ref. 25). It was further emphasized that the proposed 2 ppm tolerance level in fish would not protect "sports fishermen and others who consume abnormally large amounts of the more highly contaminated species. That population may be at risk from PCB regardless of any tolerance FDA establishes" (Ref. 25).

The FDA has urged "State and local health officials to evaluate the situation in their own localities and determine what steps, if any, they can take to address these special situations. In the past, some State and local agencies have made the FDA tolerance level for PCB applicable to fish in intrastate commerce and have issued advisories to sport fishers warning that consumption of certain species of fish should be minimized and suggesting other ways in which PCB exposure could be reduced." (Ref. 25)

Particular concern should be directed to women of child bearing age, expecially pregnant and lactating women. "In sum, although the agency concludes that a 2 ppm tolerance for PCB's adequately protects most consumers, women of child-bearing age, especially pregnant and lactating women, are among those who should be careful to avoid abnormally high exposure to PCB's in fish. They can avoid such exposure by minimizing consumption of both commercial and noncommercial fish from waters known to be contaminated with PCB's and avoiding entirely those species of sportfish known to contain high levels of PCB's" (Ref. 25).

EPA CANCER RISK MODELS

Both DDT and PCB are suspected to be human carcinogens based on animal testing studies. Cancer risk models have been developed by the Carcinogen Assessment Group (CAG) of the office of Research and Development of the EPA.

The rationale, limitations and interpretation of the cancer risk models have been summarized quite well by EDA. "Scientists have recently developed methods,

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incorporating mathematical extrapolation models, for making quantitative estimates of risks to humans based on toxicity data from animal studies. These risk assessment methods do not purport to quantify precisely the expected human risk, but rather attempt to estimate in quantitative terms an upper limit on the risk to humans that can be expected from a given level of exposure to a toxic substance, assuming humans are no more susceptible to the effect of the substance than are the most susceptible members of the animal species for which toxicity data are available. These risk assessments can be useful as a means of comparing risks at various exposure levels and illustrating the toxicological judgment that a reduction in exposure will reduce risk. Because of all the problems inherent in extrapolating from animal data to the expected human experience, however, the numbers produced by a risk assessment must be interpreted cautiously: They are estimates of upper limits on risk and, though potentially useful for comparative purposes, cannot be said to quantify actual human risk precisely. These assessments attempt to avoid underestimating human risk, but even that cannot be guaranteed." (Ref. 25)

Risk assessment models can, therefore, provide quantitative estimates of risks associated with different levels of exposure. However, the calculated risks should be understood to represent order of magnitude estimates and not precisely defined numerical values. The risk estimates are probably most useful in determination of comparative or relative risks from different exposure levels. Risk models presented below are currently being used by EPA to numerically quantify risks. One area of application is in development of water quality criteria. In this case, target risk levels judged to be acceptable have been considered to be in the range of 10^{-5} to 10^{-7} for lifetime exposure. Drinking water concentrations corresponding to the target risk levels will be determined by quantitative application of the assessment models.

Risk models currently being used by CAG for DDT and PCB take the following form,

$$R = (10^{-3})\ D\ Q^*/B \qquad (1)$$

R = Lifetime probability of observable cancer incidence, the probability of contracting an observable case of cancer in a lifetime because of exposure to a daily dose of the compound (Ref. 29).
D= Lifetime average daily dosage, ug/day
B = Body weight in kilograms, assumed to be 70 kg for a standard European man.
Q^* = Carcinogenic potency factor, $(mg/Kg/day)^{-1}$. Assumed to be 8.4 for DDT and 4.3 for PCB.

The carcinogenic potency factor is determined from toxicity studies and is based on a multi-stage dose extrapolation model. The potency factors have been the subject of review by the CAG. In response to a request from the LA/CWA Project the CAG provided the following information. "Since the publication of the proposed water quality criteria documents last year, the CAG has made some changes in the carcinogenicity based criteria. The changes were made because of the public comments to the proposed water quality criteria. One change, which affects all of the potency calculations to a minor extent, is the replacement of the one-hit dose extrapolation model by the multistage model. This has caused the potency factor for PCB's to change from 3.3 to 4.3. (mg/kg/day)$^{-1}$..... For DDT, the public comments have persuaded us to omit (the

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original factor), which was based on regional cancer rates in Israel and New York State. In addition, the CAG has decided that the Turasov et al (1973) data for male mice is not an approproate study for estimating human risk because of an unusually high tumor incidence in controls and because of the lack of a clear dose-related trend of tumor incidence. Instead, the study giving the second-highest potency, as determined with the multistage model, is now used. This is the study by Tarjan and Kemeny (1968) entitled "Multigeneration Studies on DDT in Mice" (Fd Cosmet. Toxicol. Vol. 7. pp. 215-222. Pergamon Press, 1969. Printed in Great Britain). According to the multistage model, the value is 8.4 $(mg/kg/day)^{-1}$." Ref. 28)

For the case of PCB, possible adverse effects of PCB on pregnant and lactating women and their infants have been reported. However, these effects are not included in the present CAG model since no dose-response relationship has yet been established from epidemiological studeis.

ASSESSMENT OF PUBLIC HEALTH RISK

The average daily intake of DDT and PCB from seafood depends on the concentration of these constituents in seafood and the average daily seafood consumption rate. Estimates of both seafood concentration and consumption rates can be made based upon available information. The magnitude of the public health risk can then be estimated from the CAG risk models, assuming that the average intake of trace organics remains reasonably constant over a lifetime. Based on the CAG models health risks can be calculated as a function of seafood consumption rate and toxicant concentration.

Based on the USC survey of shoreline fishing habits a median consumption rate of 36 gm/day was estimated with a 90 percentile rate of 284 gm/day. According to an estimate by Cordle et. al. (Ref. 20), the national average consumption is about 15 lb/year or 18.7 gm/day. The latter value was also used by EPA in calculating allowable concentrations of toxicants in water for the Preliminary Water Quality Criteria (Ref. 29). About 50 percent of shoreline fishermen surveyed in the USC study consume twice the national average of seafood. About 10 percent consume over 15 times the national average.

The fact that a percentage of the U.S. population consumes rather large quantities of fish was verified in a study by the Michigan Department of Public Health (Ref. 31). The median quantity of fish consumed by the study participants was in the 24-25 lb/year range, equivalent to about 30-31 gm/day. The highest recorded fish consumption over the two-year period of the Study was 180 lb/year (233 gm/day), and the highest single season consumption rate 260 lb/year (323 gm/day).

Consumption rates determined in the Michigan study are comparable to the median and 90 percentile values projected from the USC study. It appears that consumption rates an order of magnitude higher than the national average are not unreasonable for some individuals. Therefore, the median and 90 percentile estimates from the USC study will be used in subsequent analysis.

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Volatilization of DDT and PCB can occur during high temperature cooking. A study on the loss of DDT and PCB during cooking was conducted by Zabik et al (Ref. 33) on lake trout from the Lake Superior area. The trout fillet had a fat content of 26 to 29%. Cooking by broiling, roasting and microwave resulted in PCB loss of 53%, 34%, and 26%, respectively. Corresponding losses for DDT were 39%, 30% and 54%. Less fatty fish may have lower volatilization losses compared to that of the lake trout studies. In the USC Fish Usage Survey, pan frying was the favorite method of cooking. For the three fish that were most frequently caught (White Croaker, Bonito, and Pacific Mackerel), about 50% were estimated to be pan fried, 30% baked or charcoal broiled, 10% deep fried and 10% steamed, boiled or used for soup. Very little would be eaten raw. Considering the available information on volatilization losses during cooking and the varied methods of cooking, no more than 25 to 50% of the PCB and DDT would be expected to be lost through cooking. For purposes of analysis, no cooking loss of PCB and DDT was assumed.

It is difficult to estimate the average PCB concentrations in fish actually consumed by sportsfisherman. Most of the available data on trace organic concentrations has been measured in fish caught in the immediate vicinity of the outfalls. Fish samples from the USC survey are scheduled to be analyzed but data are not yet available. Estimates of trace organic concentrations can be made from the data of Table 2. Theoretically, the data are applicable only to the locations where the seafood was sampled. It will be necessary to extrapolate the data to the case of a shoreline fisherman due to a lack of more site specific data. For White croaker, the PCB concentration ranged from 0.04 to 0.12 ppm (0.06 ppm median) for 3 samples at the OCSD outfall area. However, the range was 0.3 to 10 ppm (1.05 ppm median) for data from the LACSD outfall area. For Pacific bonito, measured PCB concentrations ranged from 0.13 to 0.49 ppm (0.30 ppm median) for a sample of 3 at the LACSD outfall area. Only 1 piece of data for Pacific mackerel at OCSD outfall was available at 0.09 ppm. Based on the above a range of 0.1 to 1.0 ppm was considered representative of the PCB concentration in fish caught in the area influenced by wastewater outfall. A PCB concentration of 0.025 ppm was considered representative of the background concentration in fish from control areas.

For the case of DDT, a concentration of 0.03 ppm was used to represent the background or control condition. For the CLA and OCSD outfall areas, water column fish have been observed with DDT concentrations between 0.03 and 0.10 ppm. For the LACSD outfall system at Whites Point, however, a historically large deposit of DDT exists. The DDT concentration in water column fish appears to range above 1 ppm to over 10 ppm. In one study, white croaker was found to have a range of 5.7 to 176 ppm and a median of 11.2 ppm for a sample size of 10. Pacific Bonito was found to have a range of 0.3 to 1.2 ppm, and a median of 1 ppm for a sample size of 3.

It should be reemphasized that absolute risk levels calculated by Equation 1 are order of magnitude estimates. It is assumed that average consumption patterns remain reasonably constant over a lifetime of exposure. The assumption of lifetime exposure may be questioned since there is little or no available data on the subject of lifetime fishing habits in the outfall areas. It is known that expensive fishing occurs but the individuals are likely exposed for time periods less than a lifetime. On the other hand, risk assessment models for PCB and DDT predict a risk level proportional to total toxicant intake. Thus, exposure to an

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elevated daily concentration for a shorter time period would reduce the risk from that calculated by Equation 1 for a lifetime exposure. However, the risk would still be higher than if exposure had not occurred and would likely be proportional to total lifetime intake.

A tabular summary of relative PCB and DDT intake rates and health risks for various seafood consumption scenarios is presented in Table 5. Referring to Equation 1 and assuming body weight and body dosage to be constant, the health risk from consumption of PCB or DDT is proportional to daily dosage. The health risks shown in Table 5 were normalized assuming (1) a health risk of unity for the average U.S. consumption of PCB or DDT and (2) a health risk of unity corresponding to the control consumption. This yields a relative health risk for the different scenarios which is proportional to the average toxicant intake. Use of relative risk removes some of the previously expressed concerns over use of the CAG models to quantify absolute risk levels.

Based on the relative risks for PCB and DDT shown in Table 5 consumption of seafood from control areas, even at high consumption rates, would appear to present risks less than or equal to that associated with the present average U.S. diet. Based on representative tissue concentrations, however, consumption of fish from all outfall areas would present a relatively greater risk due to higher PCB concentrations; about twice the U.S. average for the median consumption case, and about 16 times for the 90 percentile consumption case. Consumption of fish from an outfall area would pose about a 20 times greater risk than consumption of an equivalent quantity of fish from a control area. Seafood consumption for the Whites Point area would present an elevated risk due to high DDT concentrations; about 20 times the U.S. average risk for the median consumption case, and about 180 times for the 90 percentile consumption case. Consumption of fish from the Whites Point area would pose about a 170 times greater risk from DDT than consumption of an equivalent quantity of fish from a control area.

It appears that high consumption rates of seafood from outfall areas contaminated with PCB and/or DDT will significantly increase the relative health risk to the consumer. The health risk is reduced by decreasing the consumption rate of seafood and/or consumption of seafood from relatively uncontaminated areas.

The relative health risks of Table 5 are estimates based on average conditions projected over an extended time period. Another aspect of the problem is that high single dosages of PCB or DDT can result from consumption of a small number of highly contaminated fish. Referring to Table 2, for example, PCB concentrations as high as 8 ppm have been observed. Consumption of only 500 gms of seafood at this concentration would give a dosage of 4000 ug of PCB. The latter intake is equivalent to that projected from the U.S. average diet for a period of 1.2 years. For the case of DDT, concentrations as high as 176 ppm have been measured in white croaker from the Whites Point area. Consumption of 500 gm of seafood at this concentration equates to a dosage of 88,000 ug, equivalent to that projected from the average U.S. diet for a period of 30 years.

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TABLE 5

PCB AND DDT INTAKE RATES AND RELATIVE HEALTH RISKS FOR VARIOUS SEAFOOD CONSUMPTION SCENARIOS

	U.S. AVERAGE CONSUMPTION	LA/OMA SHORELINE FISHERMAN MEDIAN CONSUMPTION		90 PERCENTILE CONSUMPTION	
		CONTROL	OUTFALL	CONTROL	OUTFALL
PCB					
Fish Consumption Rate, gm/day	18.7	36	36	284	284
Assumed Representative PCB Concentration, ug/gm (ppm)	-	0.025	0.5[a]	0.025	0.5[a]
PCB intake, ug/day	9	0.9	18	7.1	142
Relative Health Risk					
Normalized to U.S. Avg.	1	0.1	2	0.8	16
Normalized to control	-	1	20	1	20
DDT					
Fish Consumption Rate, gm/day	18.7	36	36	284	284
Assumed Representative PCB Concentration, ug/gm (ppm)	-	0.03	5[b]	0.03	5[b]
DDT Intake, ug/day	8	1.1	180	8.5	1420
Relative Health Risk					
Normalized to U.S. Avg.	1	0.14	23	1.1	180
Normalized to control	-	1	167	1	167

a. Values are typical for outfall locations within the LA/OMA area.
b. Values are typical of the Whites Point outfall only and should not be extended to the CLA or OCSD outfall areas.

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APPENDIX J

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CHANGES IN THE AMOUNT AND PROPORTIONS OF DDT AND ITS METABOLITES, DDE AND DDD, IN THE MARINE ENVIRONMENT OFF SOUTHERN CALIFORNIA, 1949–72

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ABSTRACT

This paper is about the contamination of the ocean and its biota off southern California by the pesticide, DDT. The accumulation of DDT and the changes in proportions of DDT and its metabolites in the ocean are described for the years 1949 to 1972 especially as they are reflected in the myctophid fish, *Stenobrachius leucopsarus*. This time period was characterized by continuous dumping of DDT wastes into the ocean by a large manufacturer of DDT and the cessation of this dumping in 1970. Aspects and implications of the pesticide pollution problem in the marine environment are discussed.

In January and May 1970, the Fishery-Oceanography Center, La Jolla, Calif., collected samples of fish off southern California and Baja California as their part in a survey of chlorinated hydrocarbon (CHC) pesticides in marine fishes by the U.S. fish and Wildlife Service Bureau of Commercial Fisheries (now the National Marine Fisheries Service). Each sample consisted of the livers of several specimens of a single species from one locality. The samples were sent to the Environmental Protection Agency Laboratory at Gulf Breeze, Fla., for analysis.

The results (Duke and Wilson, [illegible] showed that [illegible] fish [illegible] 3 samples [illegible] southern California [illegible] and its metabolites were found in the Los Angeles area with DDT levels declining greatly in samples taken to the north, south, and offshore from Los Angeles.

Previous pesticide residue surveys of marine birds and fish (Keith and Hunt, 1966; Risebrough et al., 1967; Risebrough et al., 1968a) had been confined primarily to central California and did not reveal the extent of DDT pollution in the ocean off Los Angeles. [illegible] Francisco that ranged from DDT residue content between 1.1 and 2.5 ppm.

In the spring of 1968, Keith, Woods, and Hunt (1970) investigated the breeding pelican, *Pelecanus occidentalis*, colony on Anacapa Island, about 35 nautical miles west of Santa Monica Bay, and found extensive reproductive failure caused by thin-shelled eggs which broke under the breeding pelicans. They found that the contents of a composite sample of many broken eggs contained 1,816 ppm DDT residues (lipid basis), while intact eggs averaged 1,215 ppm. They also sampled pelican eggs from three breeding colonies in the Gulf of California and found DDT residues averaging 58, 61, and 103 ppm. Jehl (1970) sampled pelican eggs from Los Coronados Islands, about 95 nautical miles south of Anacapa. These contained 819 ppm DDT residues. At San Martin Island, 350 nautical miles south of Anacapa, egg residues were 11.2 ppm.

[1] [illegible]

[2] [illegible]

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More recent data (Southern California Coastal Water Research Project, 1971)[2] for the *p,p'*DDE content of the mussel, *Mytilus californianus*, show that two samples taken on the Palos Verdes Peninsula, near Los Angeles, contained 61 and 151 ppm of *p,p'*DDE while samples taken at a greater distance from Los Angeles declined greatly to between 0.3 and 3 ppm at San Diego, Point Conception, and on the farther outlying islands.

Burnett (1971) determined DDT residues in samples of the sand crab, *Emerita analoga*, from 19 locations along the coast between northern Baja California and San Francisco. Only in those crabs from the Los Angeles area did he find values greater than 1 ppm (up to 7.2 ppm). The DDT values fell off rapidly north and south of Los Angeles and averaged about 0.1 ppm at most of these locations.

These results of the above studies demonstrate that geographical proximity to Los Angeles was accompanied by greatly elevated levels of DDT and its metabolites in marine organisms.

High DDT residues in marine life in the ocean off Los Angeles had an adverse effect on the fishing industry. In June 1970, canned jack mackerel, *Trachurus symmetricus*, shipped from Los Angeles was condemned by the U.S. Food and Drug Administration in New York for high DDT content (13 ppm). The FDA had set a maximum tolerance of 5 ppm on fish products. In the following year jack mackerel was withheld from distribution by the packers, and jack mackerel and Pacific bonito, *Sarda chiliensis*, were condemned by the FDA in the Los Angeles area. In December 1970, the FDA seized about 8,000 lb of white croaker, also called kingfish, *Genyonemus lineatus*, that had been caught near Los Angeles. These contained 19 ppm DDT residues.

While the fishing industry was unable to pinpoint any particular area of heavy DDT contamination of pelagic fish off southern California, it seemed to be fairly well defined for the more sedentary bottom dwelling species. Although the total DDT in the flesh of the Santa Monica Bay fish samples taken in May 1970 ranged from 12 to 57 ppm, about 30 nautical miles away at Farnsworth Bank on the west side of Santa Catalina Island, DDT in the flesh of a sample of sculpin, *Scorpaena guttata*, and in flesh samples of four species of rockfishes, *Sebastes* spp., had a range of only 0.23 to 0.49 ppm; and, a sample of white croakers taken off Oceanside, 40 nautical miles south of Los Angeles, contained only 0.61 ppm of DDT residues in the flesh.

The pelagic fish were not good indicators of the source of pesticide contamination because they are much more migratory than the bottom dwelling species, and the area in which they are caught is not necessarily the area in which they were contaminated. Even though this would also mean that their exposure to heavy contamination would be of shorter duration than for bottom fishes living in these areas, they still built up high concentrations of DDT in the flesh because pelagic fish tend to store fat throughout the body rather than in the liver as do bottom dwelling, more sedentary species. The DDT residues are stored in the fats, and the distribution of the total body load of DDT residues in the fish is roughly related to the distribution of fat.

Although we have no flesh sample analyses from pelagic fish to illustrate this point, concentrations of DDT were found to be two to six times higher in the livers of samples of four different species of bottom dwelling fish taken in 1970 along the coast between San Diego and Oceanside than they were in the livers of a sample of jack mackerel from the same area, and seven to 19 times higher than in the livers of a sample of Pacific sardine, *Sardinops sagax*, taken in San Diego Bay at about the same time. And even among bottom fish taken from the same area at the same time, those that have more oil in the flesh seem to carry relatively more of the total DDT load in the flesh. For five species of bottom dwelling fishes taken from Santa Monica Bay in 1970, there is an inverse relation between the ratio of DDT in the liver to DDT in the flesh and the percent of oil in the flesh as given in Table 1.

Because of the prevalence of winds from the Pacific, and the concentration of agriculture in the inland valleys, we considered it unlikely that the heavy DDT contamination in the ocean off Los Angeles was caused by airborne pesticide residues. Surface runoff was also an unlikely source. Southern California's arid climate, the dominance of rivers, the large population and consumption of water have resulted in a condition in which the annual discharge of rivers into the ocean is at least twice the average annual surface runoff of

[2]Southern California Coastal Water Research Project, 1971. Comments on the effects of discharges of DDT and PCB's into the State Water Quality Control Board presented at the 21 Sept. Water Resources Control Board public hearing in San Diego, Calif., 2 Dec. 1971, 25 p.

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TABLE 1.—Relation between ratio of DDT in liver to DDT in flesh and percent of oil in flesh of five species of bottom dwelling fishes from Santa Monica Bay in 1970.

Species	Number of fish	Total DDT		Ratio of DDT	Percent oil in flesh
		Liver (ppm)	Flesh (ppm)	Liver:flesh	
Bocaccio, *Sebastes paucispinis*	9	590	12	49:1	1.4
Starry rockfish, *S. constellatus*	5	1,030	57	18:1	1.8
Vermilion rockfish, *S. miniatus*	10	163	16	10:1	2.2
Dover sole, *Microstomus pacificus*	13	63	13	5:1	3.6
Sablefish, *Anoplopoma fimbria*	10	103	23	4:1	6.0

water. The "rivers" of southern California are its sewers, and the two largest of these, in the 400 million gallons (1.51 million m³) per day class, are the outlets of the Hyperion treatment plant that serves the city of Los Angeles and those of the White Point treatment plant that serves Los Angeles County.

The Hyperion plant empties into the head of an underwater canyon in the northern half of Santa Monica Bay, and the White Point plant empties into the ocean off Palos Verdes Peninsula. Fish samples that showed very high DDT residues came from southern Santa Monica Bay about midway between the two sewer outfalls.

The County Sanitation Districts of Los Angeles County (CSDLAC) began a monitoring program to test for CHC pesticides in its sewerage system in December 1969 (Carry and Redner, 1970). They found that very high concentrations of DDT were present in the sewer system. In March 1970, they began to sample the sewer trunk lines in order to pinpoint the sources of DDT input into the sewer system.

They soon discovered that the source of most of the DDT pollution was the Montrose Chemical Corporation, a major manufacturer of DDT, located in the city of Torrance. Los Angeles Times staff writer, John Dreyfus, reported (7 October 1970), after interviewing a Montrose official, that at that time, Montrose was the only manufacturer of DDT left in the United States, and that it accounted for two-thirds of the world's sales of DDT.

The CSDLAC found that water samples taken from the sewers immediately upstream from Montrose contained 34 parts per billion (ppb) of DDT and its metabolites (DDD and DDE) in a flow of 25.3 million gallons (95.8 thousand m³) per day or 7.2 lb (3.27 kg) of total DDT per day, while samples taken immediately downstream contained 2,950 ppb in a flow of 26.6 million gallons (100.7 m³) per day or 654 lb (297 kg) of total DDT per day (Carry and Redner, 1970).

In April 1970, Montrose began hauling most of its processing wastes to a storage area, which caused a considerable drop in CHC entering the CSDLAC disposal plant. However, in May 180 lb (81.6 kg) per day CHC, of which 150 lb (68.0 kg) was DDT and its metabolites, were still found to be entering the White Point plant. The primary source of this was found to be the sewer trunk line serving Montrose Chemical Corporation. Because the composition of the total DDT sampled, 14% DDT, 48% DDD, and 38% DDE, was different from the Montrose effluent previously sampled, 74% DDT, 5% DDD, and 21% DDE, CSDLAC personnel concluded that the primary source of pollution was from old deposits in the sewer lines.

Between 11 December 1970, and 1 July 1971, 567,000 lb (257,000 kg) of deposits, of which 7,700 lb (3,500 kg) were total DDT, were removed from the interceptor system that served Montrose (Redner and Payne, 1971). The cleaning of this section of the sewer lines also stirred up old deposits which were washed down into the sewerage disposal plant, resulting in an increase in total DDT entering the plant. By October 1971, the total CHC entering the disposal plant had decreased to 60 lb (27 kg) a day of which 28 lb (13 kg) was total DDT and the remaining 32 lb (14 kg) polychlorinated biphenyls (PCB).

Since March 1971, an average of 22,000 gallons (83.3 m³) a day of alkaline waste from the Montrose plant has been trucked to the Sanitation District's landfill on Palos Verdes Peninsula, and another 700 gallons (2.6 m³) of acid waste has been trucked to a disposal site. The alkaline waste was found to contain about 3,000 ppm of total DDT (Redner and Payne, 1971).

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per day. The acid waste was not tested, but if the concentration of DDT was similar to that in the alkaline waste, it would amount to an additional 175 lb (79 kg) of DDT residues per day.

The average inflow of DDT into the White Point sewerage plant during December 1969 through March 1970 was estimated at 652 lb (296 kg) per day. The amount measured in the sewers at the Montrose plant was 647 (293 kg) per day. The amount trucked out as alkaline waste only was estimated at 550 (250 kg) per day. Considering the difficulties in sampling such large volumes of material and the fact that the samples were taken in different localities at different times, there is remarkable agreement among them.

It is difficult to determine just how much DDT finally was pumped into the ocean after treatment at the sewerage plant. Some of it was undoubtedly removed in grit, grease skimming operations, and in dried sludge.

At the Hyperion treatment plant (city of Los Angeles), the digested sludge is pumped into the ocean, although some of it, at least in the past, has been used for fertilizer. The DDT input into the Hyperion plant was estimated to be on the order of 0.6 lb (0.27 kg) a day (tests by Hyperion personnel cited in Los Angeles Times, 7 October 1970) so, insofar as the DDT input into the ocean is concerned, it has had little impact. The White Point treatment plant has never discharged its sludge into the ocean (Terry Hindrichs, Southern California Coastal Water Research Project, pers. commun.) except during a short period of heavy rains in 1955. Until 1959, digested sludge was spread on nearby fields to air dry. Since 1959 a centrifuge has been used to partially dry sludge. The resulting cakes have been used for fertilizer or landfill.

CSDLAC personnel were unable to get reliable estimates of the DDT content of their effluent into the ocean until December 1970 (Carry and Redner, 1970), long after Montrose stopped dumping most of their wastes. Nine samples that they took from the effluent into the ocean in December showed that the average total CHC entering the ocean was 130 lb (59 kg) a day. The influent into the sewerage disposal plant in December had a load of 1,544 lb (701 kg) per day. The influent samples were taken after the grit chambers so any CHC removed in grit would not have been included. If we assume that sludge removal accounted for a 15% loss of CHC in December 1969 through March 1970, between influent (average 652 lb or 296 kg per day) and effluent into the ocean, then the ocean discharge would have been about 552 lb (250 kg) per day of CHC for these months. This is about 100 short tons (91 metric tons) per year or about 10 times the amount of pesticides estimated to be carried into the Gulf of Mexico each year by the Mississippi River (Butler, 1969).

Montrose received a permit to dump its wastes into the CSDLAC sewer system in 1953, but it had been dumping for a few years before that according to company personnel. The continuous dumping of large quantities of DDT wastes into the ocean at a single point over a period of about 20 yr presented an unparalleled opportunity to study the effects of DDT on the ocean environment. Unfortunately the one-time opportunity to take advantage of the situation was not fully realized until some time after the dumping had stopped, and no large-scale coordinated investigation was undertaken to exploit this ecological windfall.

An investigation of pesticide pollution of the marine environment was initiated at the Fishery Oceanography Center (FOC), La Jolla, in 1970. Personnel at FOC have collected samples of bottom muds, fishes, and other biological samples primarily from the ocean off Los Angeles in order to study the effects of heavy DDT pollution in the marine environment.

Collections of marine organisms taken for other purposes, some dating back to 1949, were available for study. Most of the present paper is based on DDT levels found in specimens from one of these collections of a myctophid fish, *Stenobrachius leucopsarus*, found in the ocean off southern California in an attempt to trace the historical buildup of DDT and its metabolites in the marine environment as reflected in this species.

MATERIALS

The California Cooperative Oceanic Fisheries Investigations (CalCOFI) has taken plankton samples over an extensive area off California and Baja California since 1949. These samples were obtained over a predetermined pattern of stations in order to determine the species present, their numbers, and their distribution. The most intensive sampling took place during the 1950's, during the 1960's the number of CalCOFI cruises was reduced considerably.

Although not all of these collections were made for quantitative analysis, most of the collections [illegible]

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specimens of the myctophid fish, *S. leucopsarus*, that had been sorted from the plankton collections, were selected for this study to give best areal and temporal coverage.

Initially a few plankton samples, which were available in much greater quantity, were tested for pesticides. However, the plankton species composition varied in time and with locality, and it was felt that the samples might not be comparable. The plankton samples also appeared to contain both Aroclor 1242[3] and Aroclor 1254 (polychlorinated biphenyls (PCB) manufactured by Monsanto Corporation) while the myctophids generally contained only Aroclor 1254 in quantity. Plankton samples can include man-produced debris that contains relatively large amounts of CHC or other organic chemicals which interfere with analysis, while individual myctophids are relatively free of such material. Myctophids do not undergo any more horizontal movement than other plankton organisms, and, if they use their motility at all, at least in the coastal waters, it is probably to maintain position over the deeper basins. In addition, they tend to contain more pesticide than the invertebrate constituents of the plankton with which they are taken, and they are convenient material to work with.

The myctophids tested for pesticide residues ranged in standard length (SL) from 14 to 77 mm. They are apparently short-lived fish. Fish of the year can be followed through their first year and into their second by length-frequency distributions (Figure 1). Most of the myctophids tested appeared to be comparable in DDT content to other fish taken at the same time and place, but the amounts in smaller fish were erratic. Some

[3]Reference to trade names does not imply endorsement by the National Marine Fisheries Service, NOAA.

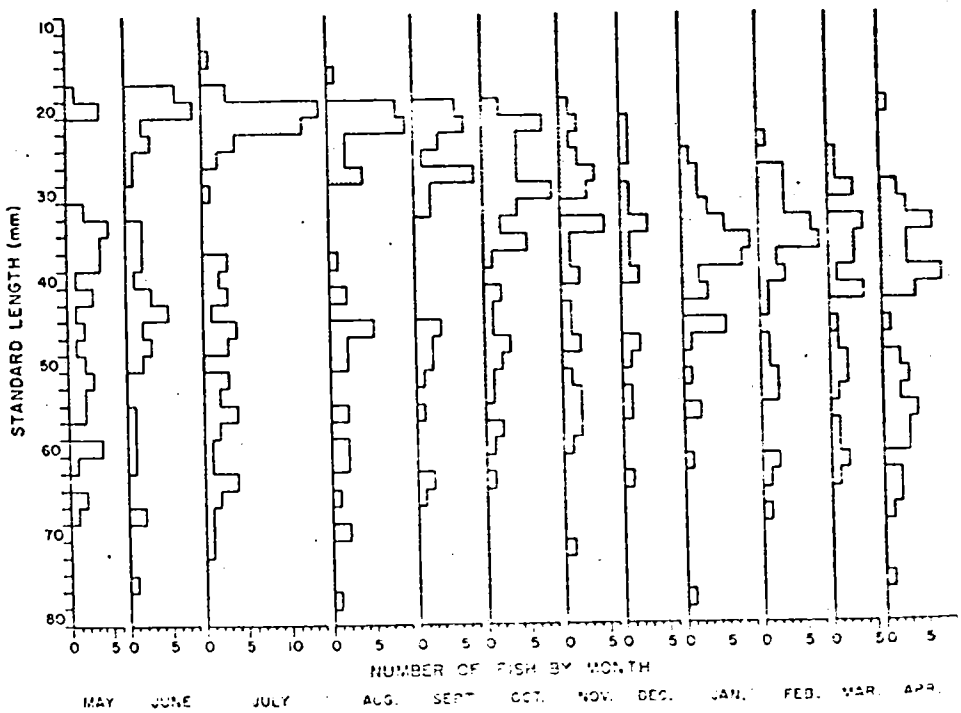

FIGURE 1.—Length frequency distribution [illegible]

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were comparable to larger fish, while others contained less DDT than might be expected in larger fish taken at the same time and in the same locality.

This variation in pesticide content appeared to be related to the "fat" content (hexane extractable portion of the fish) of the specimens. The fat content of the fishes (Figure 2) increased very rapidly and with considerable variation to 30 mm length, 6.5% fat of the dry weight of the fish in an 18-mm specimen to 42.5% in a 29-mm specimen where it began to level off. In mature fish the fat is about 49% of dry weight and 16% of wet weight. There is no apparent seasonal fat cycle. For comparison of DDT in time and space, only myctophids 30 mm or longer were used.

METHODS

The myctophids used in this study were preserved in Formalin which had no apparent effect on the pesticides to be analyzed. The specimens were measured and weighed and placed in tared disposable pipets that had been plugged with glass wool at the small end, or for larger fish in similarly prepared glass tubing of appropriate size. The fish were dried in an oven at 65°C to constant weight and reweighed to obtain dry weight. Each fish was macerated in the tube and extracted into a 15-ml graduated centrifuge tube with 10 ml of hexane. The remains of the fish in the pipet were dried and reweighed to obtain the weight of material extracted.

The extract in the centrifuge tube was mixed to uniformity, and an aliquot equal to 20 mg or less of fat removed. This was reduced in volume if necessary and passed through an activated alumina column as described by McClure (1972). The cleaned up sample was again reduced in volume if necessary and injected into a model 402 Hewlett Packard gas chromatograph (GLC) with a Ni^{63} electron capture detector. The 6-foot glass column contained 1.5% OV-17/1.95% QF-1, on 100 120 mesh Supelcoport.

DDT gets its name from its former chemical designation, *p,p'*-dichlorodiphenyltrichloroethane. The current chemical designations for DDT and its metabolic products mentioned in this paper are:

p,p'-DDT	1,1,1-Trichloro-2,2-bis(*p*-chloro-
p,p'-DDD (TDE)	1,1-Dichloro-2,2-bis-*p*-chloro-
p,p'-DDE	1,1-Dichloro-2,2-bis-*p*-chloro-
p,p'-DDMU	1-chloro-2-(*o*-chlorophe-
Kelthane (Dicofol)	1,1-bis-(*o*-chlorophenyl)-2,2,2-trichloroethanol

For the ortho-para isomers of DDT, DDD, DDE, and DDMU substitute 2(*o*-chlorophenyl)-2-(*p*-chlorophenyl) for 2,2-bis(*p*-chlorophenyl). In this paper total DDT includes *p,p'*DDT, *o,p'*DDT, *p,p'*DDD, *o,p'*DDD, and *p,p'*DDE. While *o,p'*DDE and *p,p'*DDMU are present, although not as major constituents of the fish samples, both have the same short retention times on the column used and are interfered with by a number of other unknowns as tends to be true of anything having a shorter retention time than *p,p'*DDE in these samples; therefore they were omitted because of the difficulty in identification and quantification. Kelthane was also omitted because it breaks down on this column (Morgan, 1967) to a material that has a low response and an even shorter retention time than DDE.

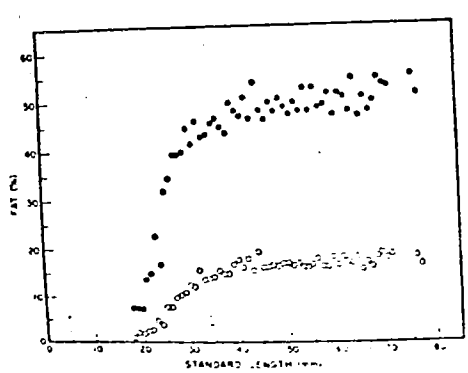

FIGURE 2.—Increase in percent fat with increase in length for *Stenobrachius leucopsarus*. Dark circles equal fat as a percent of dry weight, open circles as a percent of wet weight. Fat equals hexane extractable substances. Pesticide [illegible] with standard length (SL) were not used because of the greater variation in these values than in larger fish in which fats tended to be more stabilized.

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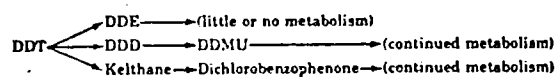

Since we have no measurements of Kelthane, the scope of this paper includes only the measurement of the metabolism of DDT to DDE and DDD. As mentioned earlier, the effluent from the Montrose plant was already partly metabolized (Carry and Redner, 1970). In seven samples taken between 14 August and 24 November 1970, the total DDT portion of the effluent contained 74% (range 62–84) of DDT, 5% (3–7) of DDD, and 21% (9–35) of DDE. During this period the effluent contained 2 lb or less of DDT per day. The proportions of DDT, DDD, and DDE at the time when dumping was 650 lb (295 kg) per day were 73:2:25.

At the beginning of this investigation some pesticides were separated on other columns to confirm the identification of DDT and its metabolites. Additional confirmation was obtained by dehydrochlorinating samples with alcoholic KOH which converts DDT and DDD to their respective ethylene derivatives, DDE and DDMU, but does not change the PCB, Aroclor 1254.

Because there are so many possible sources of variance to the estimates of pesticide content, we cannot obtain a precise measure of this error. Based on the least accurate measurements made in the course of analysis, the standard error of the amount of pesticide in a sample should be about plus or minus 10%. The error may be increased by shortcomings in methodology and by the presence of other peaks that interfere with those to be quantified. At low pesticide values the error increases, and it may be more like plus or minus 100% at values on the order of 10 ppb. However, the absolute error is only a few parts per billion also and makes little difference when values that differ by orders of magnitude are being compared.

In the myctophid samples, Aroclor 1254 seemed to be the only substance that contributed peaks on the chromatogram of any significance which could interfere with quantification of the DDT series. Six Aroclor 1254 peaks span the retention time range of *p,p'*DDE, *o,p'*DDD, *o,p'*DDT, *p,p'*DDD, and *p,p'*DDT (Figure 3). In all the marine samples examined, *o,p'*DDT and *o,p'*DDD are present in either very small quantities or not detectable at all unless the samples contain very large quantities of *p,p'* DDT or *p,p'* DDD. In the myctophid samples, Aroclor 1254 seems to maintain its integrity very well. There is no apparent selective breakdown of its components, and the pattern of peaks from myctophid samples containing this PCB and very little pesticide closely resemble the Aroclor 1254 standard (Figures 3 and 4).

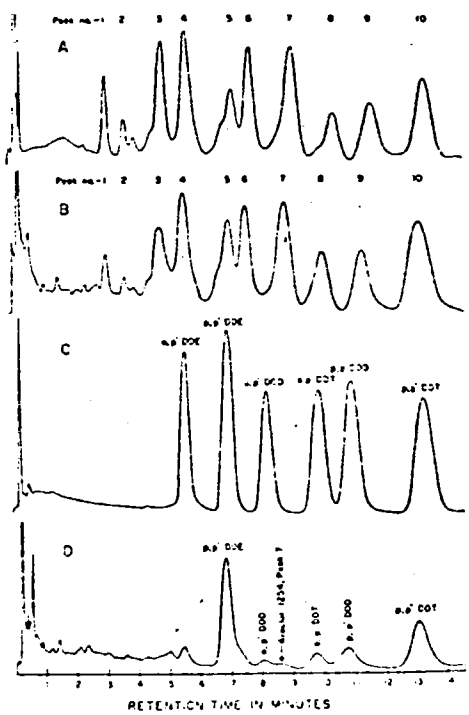

FIGURE 3.—A. Aroclor 1254 standard; column: 1.5% OV-17 1.95% QF-1, 100 120 mesh Supelcoport. B. Sample of two *Stenobrachius leucopsarus* each 20 mm standard length (SL) taken in July 1951, at CalCOFI station 70 100. About 0.54 ppm Aroclor 1254 with peak no. 5 increased slightly by 0.2 ppm DDE and peak no. 10 by 0.3 ppm DDT. Less highly chlorinated Aroclor peaks 1, 2, and 3 may be breaking down in the environment, more highly chlorinated peaks no. 4 through 10 tend to maintain their integrity of pattern. Same column as A. C. Standard of six DDT analogs. Same column as A. D. Sample of a 35 mm SL *Stenobrachius* taken in November 1955 at CalCOFI station 93 30. About 2.5 ppm total DDT. Because of the high DDT content of the sample, it was not concentrated as much as sample B, but contains at least as much Aroclor 1254 as sample B. Same column as sample A.

J-7

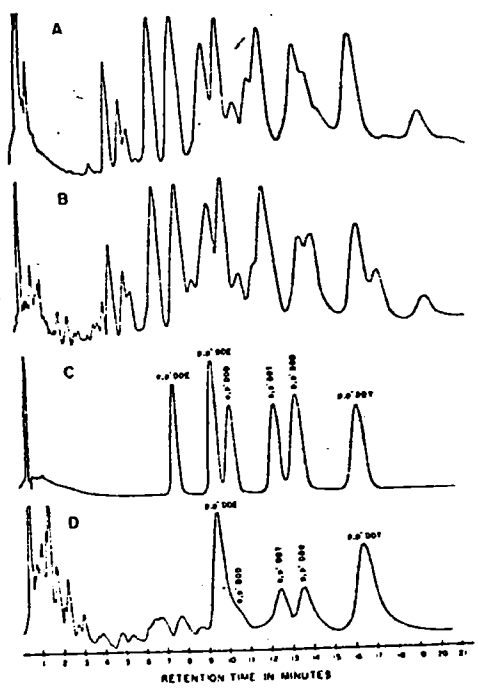

FIGURE 4.—A. Aroclor 1254 standard; column: 4% SE-30/6% QF-1, 100/120 mesh Supelcoport. B. Sample of a 28-mm *S. leucopsarus* taken in November 1955 at CalCOFI station 83.55. Aroclor 1254, 4.2 ppm; pesticides not measured. Same column as A. C. Standard of six DDT analogs. Same column as A. D. Sample of one 37-mm *S. leucopsarus* taken in March 1954 at CalCOFI station 85.45. 1.0 ppm total DDT. Same column as A.

It is apparent (Figure 3) that the seventh of the Aroclor peaks is not interfered with by the DDT series. The two ortho-para prime peaks bracketing it are generally small or absent. Therefore, it may be used to correct the DDT series for PCB interference and to quantify the Aroclor 1254.

An estimate of peak area, peak height times width at one-half peak height, was used in quantification. Increasing chart speed makes it possible to measure the width more accurately. Peak area rather than peak height is a more accurate measurement of the combined effects of two CHC when their retention times are about the same. Because GLC operating conditions may change gradually during a sample run, one pesticide standard was injected for every two samples so that each sample would have an adjacent standard for quantification.

To correct the areas of the combined peaks of the DDT series and Aroclor 1254 to the area representing pesticide only, we let X equal the area of each peak at the respective retention time of each of the DDT series and Y equal the area of Aroclor peak no. 7. Then for our operating conditions and Aroclor standard, the areas allotted to the components were:

Combined peaks	Area of Aroclor	Area of DDT series
*p,p'*DDE + Aroclor no. 5	0.24*Y*	*X* - 0.24*Y*
*p,p'*DDD	0	*X*
*o,p'*DDT + Aroclor no. 8	0.54*Y*	*X* - 0.54*Y*
*p,p'*DDD + Aroclor no.9	0.73*Y*	*X* - 0.73*Y*
*p,p'*DDT + Aroclor no. 10	0.95*Y*	*X*- 0.95*Y*

An estimate of Aroclor 1254 was obtained by multiplying the area of the no. 7 Aroclor peak by 12.3 and quantifying against the area of the *p,p'*DDE standard, or multiplying by 9.6 and quantifying against the area of the *p,p'*DDT standard. The subtractive corrections for the DDT series were confirmed in part for a few samples by calculating values both before and after dehydrochlorination with alcoholic KOH.

In a few samples taken far from the sewer outfall and in the earlier years, Aroclor 1254 was high enough to mask out the DDT residues except for slight increases in some peak areas (Figure 3). In such cases the pesticides were present in such small quantities that it made no appreciable difference in the overall results what small values were assigned to them. The illustrated example is an extreme case of masking.

In most of the samples the DDT residues dominated the PCB peaks and over the range of the six pesticide standards (Figure 3), only peaks no. 6 and 7 of Aroclor 1254 were evident. If DDT residues were high, peak no. 6 was evident as a widening of the base of the *p,p'*DDE peak (Figure 3).

RESULTS AND DISCUSSION

The pattern of CalCOFI stations from which the samples were obtained extends across the north flowing coastal countercurrent and into the southflowing California Current cutting across the counterclockwise eddy or gyre that develops between the two currents. At a depth of 200 m be-

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California Current is usually farther offshore than at the surface (Wyllie, 1966). In April and May this current moves inshore eliminating the countercurrent at the surface and sometimes at 200 m. When the California Current is offshore, the surface countercurrent develops; when it moves onshore, the surface countercurrent is absent although the southern California eddy usually persists.

The currents, and consequently the distribution of the sewer discharge, are influenced locally by such factors as the configuration of the coast, the presence of islands, the topography of the ocean floor, and the short range effects of winds and tides.

The total DDT data for the myctophids were divided into four time periods, and the average DDT value determined for all specimens taken at each station, or combined stations if they were very close together, for each time period (Figures 5-8). The total DDT content of the fish tended to be high near the sewer outlet and decreased away from the outlet. Total DDT values increased with the passage of time.

Total DDT for the purpose of this discussion consists of DDT, DDE, and DDD. Although total DDT content in the myctophids increased with time, this did not hold true for each of the three constituents. DDT increased for a few years until metabolism and dispersion equalled input and then leveled off. DDD acted in a similar manner but at a lower level. Most of the increase in total DDT after the first few years was caused by the increase in the persistent metabolite, DDE. The

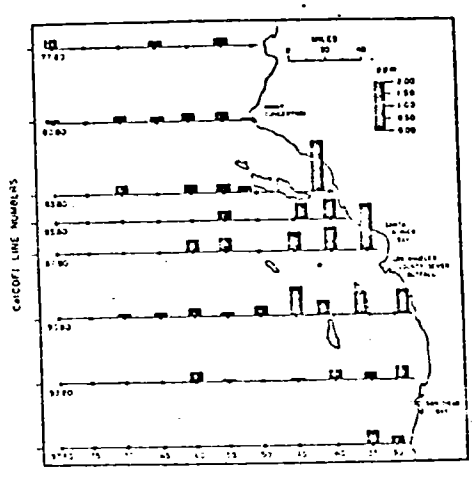

FIGURE 6.—Average total DDT at CalCOFI stations off southern California for the 4 yr 1953–56.

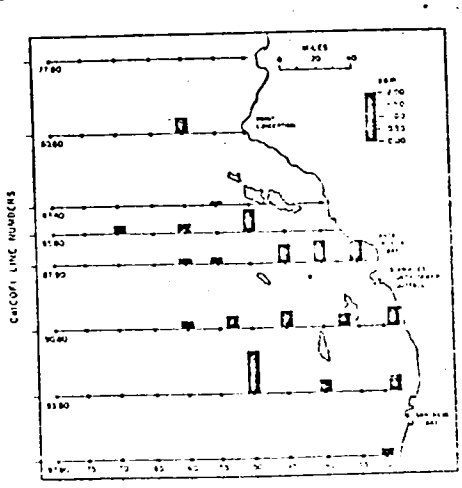

FIGURE 5.—Average total DDT at CalCOFI stations off southern California for the 4 yr 1949–52.

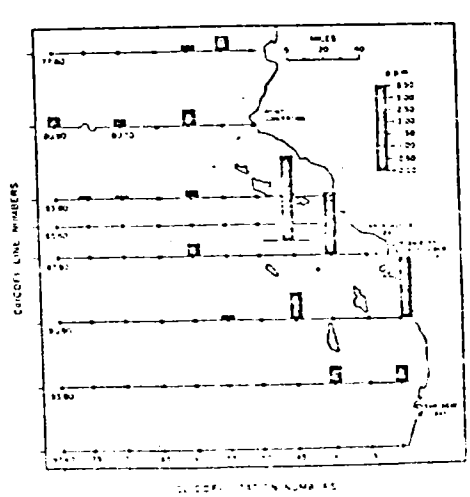

FIGURE 7.—Average total DDT at CalCOFI stations off southern California for the 4 yr 1957–60.

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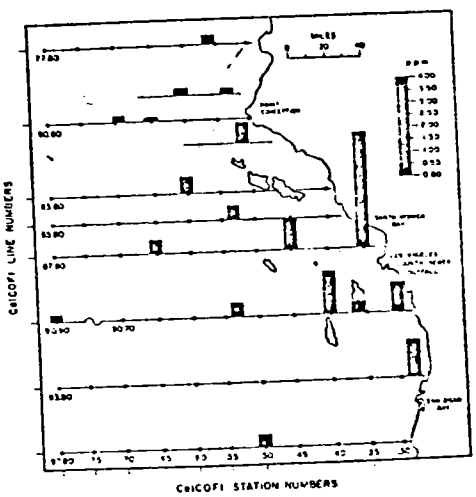

FIGURE 8.—Average total DDT at CalCOFI stations off southern California for the 6 yr 1961–66.

increase in *p,p'*DDE relative to *p,p'*DDT for the years 1950-51 through 1965-66 in the myctophids was:

Year	*Ratio of DDE to DDT*
1950–51	0.33:1.00
1952–53	0.36:1.00
1954–55	0.69:1.00
1956–57	1.06:1.00
1959–60	1.14:1.00
1961–62	2.02:1.00
1963–64	2.39:1.00
1965–66	3.96:1.00
(1970)	(4.74:1.00)
(1972)	(8.80:1.00)

These data show a 12-fold increase in the amount of DDE relative to DDT from 1950–51 to 1965–66. The ratio for the fish taken in 1970, 65–70 nautical miles southeast of the sewer outlet (in La Jolla Canyon) indicates a continuing increase in the ratios, although there were only two fish in the sample. The 1972 sample, consisting of only five myctophids, was taken west of Santa Catalina Island and about 25–30 nautical miles south southwest of the sewer outfall about 2 yr after the dumping of DDT into the sewer system had stopped. The high ratio may reflect in part continued metabolism of DDT without replenishment.

Because there are no data on the amount of DDT discharged into the ocean through the White Point sewer outfall each year, I have assumed that it was constant and discharged continuously throughout the year. Under these circumstances the amount of DDE (and DDD) entering the marine environment should gradually have increased in the earlier years until the input of DDT equalled the amount of DDT metabolized, when the input of DDE (and DDD) would also be constant. This is indicated by the initial slower increase in ratios of DDE to DDT.

If we assume that the same amount of pesticide is released into an environment each year and that it is released continuously throughout the year we may empirically represent the accumulation of the pesticide in the environment by the formula

$$Y = K(1 - S^X)$$

in which Y equals the amount of pesticide accumulated at the end of X years; K equals the maximum amount of pesticide that could be accumulated by the organism under the prevailing conditions; and S equals the "survival" rate of the pesticide for 1 yr.

In some of the years from 1949 to 1966, CalCOFI cruises were limited, and fewer samples were taken. Also the fish were not uniformly sampled with respect to distance from the sewer outfall in each of the years. But, by averaging the *p,p'*DDE content of all fish taken in each year and grouping years by twos, a rough indication of the increase in *p,p'*DDE was obtained to compare with theoretical values of the formula, $Y = K(1 - S^X)$ (Figure 9).

The almost linear increase in *p,p'*DDE indicates that its metabolism is very low. In fact, metabolism in this case would include *p,p'* DDE lost by removal from the area under study, and, therefore, the data indicate that very little was lost from this area during the years in which dumping occurred.

Because of the apparent lack of metabolism of *p,p'*DDE, this metabolite of *p,p'* DDT should give the best picture of areal and temporal buildup of CHC in the ocean as a result of the sewer discharge.

Data on *p,p'*DDE content of the myctophids, year of capture with 1949 equal to year 1, and distance in nautical miles from the sewer outfall to the place of capture were fitted to the formula

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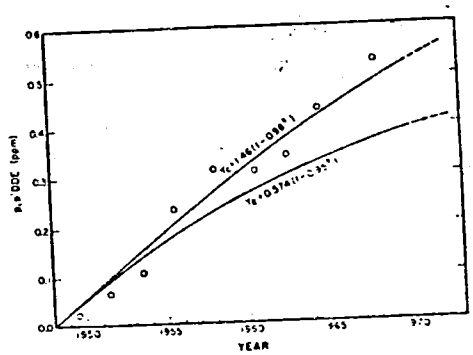

FIGURE 9.—Increase in *p,p'*DDE in the ocean off southern California, 1949–70. The points are averages of all stations combined in 2-yr groupings. Because the same patterns of stations were not run each year, myctophids were not obtained from the same stations or the same number of stations each year. Also pesticide concentrations were more dependent on distance from the point source of contamination than on year. This makes the coarse grouping of data necessary when increase in DDE with time only is considered. The two theoretical lines are computed to the formula $Y_t = K(1-S^{X_1})$, in which Y_t = computed value of *p,p'* DDE, K = value at which metabolism, excretion, and dispersal of DDE equals input, S = survival of DDE for 1 yr, and X = year with 1949 considered as year no. 1. The data indicate that *p,p'* DDE is very stable. For the 95% survival curve, which more closely fits the data, 90% of the equilibrium value would not be attained for 114 yr.

$$\log Y = \log a + b \log X + c \log X'$$

in which Y = calculated value of DDE in parts per billion, X = distance from sewer outfall in nautical miles, and X' = year. The data were grouped for greater ease of computation and to minimize individual variations which tend to distort the actual values transformed from log–log calculated values if not minimized by averaging.

The values determined for the above equation are:

log *a*	3.054
b (distance)	−1.062 (SE 0.057)
c (year)	1.423 (SE 0.122)

The correlation coefficients are:

multiple	0.973
partial (*b*)	−0.829
partial (*c*)	0.522

all of which are significant at P < less than .001.

The computed lines did not fit the data for 1949, 1950, and 1951 very well. These years were left out of the calculations because the input of DDE was rising relatively rapidly at this time and did not begin to stabilize until about 1953. Also in these earlier years, the influence of the sewer discharge of pesticide extended out to only about 100 nautical miles from the outfall. In the following years the influence of the sewer discharge increased rapidly to between 300 and 400 nautical miles from the outfall before becoming indistinguishable from the ocean background. Although there are no extensive data for any one station throughout the period under study, we can now calculate values for a theoretical station 20 nautical miles from the sewer outfall from the DDE–time–distance formula and in conjunction with the observed changes in ratios among the various DDT analogs, obtain a description of the metabolism of DDT in the marine environment as reflected in the myctophid fish, *S. leucopsarus*.

Because *o,p'*DDE was not quantified, we used only *p,p'* DDE, *p,p'*DDT, and *p,p'*DDD in the ratios. In more than 300 myctophids 30 mm or longer in standard length in which the above three constituents and *o,p'*DDT and *o,p'* DDD were measurable, *o,p'*DDT and *o,p'*DDD averaged 22.3% of *p,p'*DDT and *p,p'*DDD. In samples of commercial DDT that were tested *o,p'*DDT averaged about 25% of *p,p'*DDT.

From the calculated values of DDE and ratios of DDE to DDT, we can calculate that at our theoretical 20 mile station DDT accumulates in the fish up to 1.077 ppm when input equals metabolism. From this we may calculate that:

$$Y_t = 1.077(1 - 0.709^X)$$

in which Y_t equals calculated *p,p'*DDT and X equals the year with 1949 equal to year 1. From the values obtained (Table 2, Figure 10) we may recalculate values for DDE. These values remain essentially the same as those calculated from the DDE–time–distance formula for the later years but make allowances for lower input from DDT for the earlier years if we use the formula:

$$2.046Y_t = 0.368X - 1.077 + 1.077\ 0.709^{X_1}$$
$$\text{or} \quad Y_t = 0.180X - 0.526 + 0.526\ 0.709^{X_1}$$

in which Y_t = calculated *p,p'*DDE and X equals the year and in which we assume that there is no further metabolism of DDE.

J-11

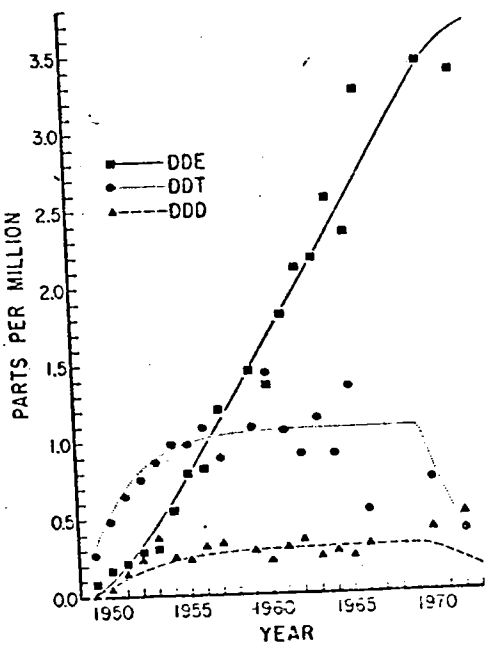

FIGURE 10.—Trends of *p,p'*DDE (squares), *p,p'*DDT (circles), and *p,p'*DDD (triangles) in the ocean off southern California, 1949–72, at a theoretical station 20 nautical miles from the point source of pesticide contamination. Computed lines show persistant DDE increasing until dumping of DDT wastes ceased in 1970. Both DDT and DDD increase for several years and then level off when metabolism, excretion, and dispersion equal input. Points are based on calculated total value of the three analogs distributed among them on the basis of the observed ratios of the three analogs to each other for each year. The 1972 ratios were affected by sewer cleaning operations that caused large quantities of DDD to enter the ocean.

From the calculated values of DDT and the DDD:DDT ratios we may estimate values for DDD. From these it appears that DDD accumulates in the fish up to 0.302 ppm where input equals metabolism. From this we may calculate that $Y_d = 0.303(1 - 0.525^{A})$. However, this formula is based on a constant input equivalent to 0.189 ppm. The actual input from metabolism of DDT was only 0.023 ppm the first year and increased to 0.181 by the 10th year, and 0.189 by the 20th year. By adjusting for these increasing inputs we obtain accumulative values of 0.0 for DDMU, and other metabolites of 0.227 (Table 2, Figure 10).

The percent distribution of total DDT among *p,p'*DDT, *p,p'*DDE, and *p,p'*DDD did not appear to change in myctophids with distance from the sewer outfall. Therefore the percent distribution which is based on large numbers of fish in most years can be used to prorate the total *p,p'*DDT obtained from the curves to obtain "observed" values of *p,p'*DDT, *p,p'*DDE, and *p,p'*DDD (Table 1, Figure 10). Both the curves and their observed values are based on observed percent changes in the composition of total DDT transformed to ppm values of the three constituents at a theoretical station 20 nautical miles from the sewer outfall.

It should be emphasized that the above description of metabolism is only an indication of what is taking place in the ocean. It neither describes the metabolism of DDT in the myctophid fish nor the metabolism in the marine environment, but rather reflects selective storage of DDT and its environmental metabolites in one species of fish.

Three factors determine the amount of CHC found in myctophid fishes: 1) The CHC present in the fish's environment during its brief life span; 2) the selective absorption of CHC through the gills and the ingestion of selected food particles; 3) and the selective storage, metabolism and excretion of CHC. Factors 2 and 3, above, should remain constant for each generation of fish. Therefore, the changes in composition of total DDT probably reflect changes occurring in the environment. However, the percent composition found in the myctophids may not represent the percent composition in the environment because of the selective nature of intake and excretion.

Some of the DDT was changed to DDE and DDD before entering the ocean. Sixteen samples of sewer discharge from the Montrose Chemical Corporation taken between 14 August 1970, and 12 May 1971, averaged 74% DDT, 20% DDE, and 6% DDD (Redner and Payne, 1971). Although these samples represented discharges averaging less than 0.5 lb (0.23 kg) a day, samples taken earlier in 1970 when dumping was estimated at 640 lb (290 kg) per day also had ratios of 73:25:2. These percent ratios are very much like the 74:23:2 distribution in the myctophids in 1949 and the 70:23:7 distribution in 1950.

Although some DDT was converted to DDD and DDE before it left Montrose, most of the metabolism took place after it was discharged from the plants. This is indicated by the percent distribution of DDT, DDE, and DDD in the myctophids in 1970, 1972 (by the settling data taken

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TABLE 2.—Calculated values of *p,p'*DDT, *p,p'*DDE and *p,p'*DDD and their observed percent distribution in the myctophid fish *Stenobrachius leucopsarus*, at a distance of 20 nautical miles from the point source of pollution in the ocean off southern California for the years 1949 through 1973.

Year	Annual input (ppm)	Accumulated input (ppm)	Calculated accumulated *p,p'* DDT (ppm)	Metabolites of *p,p'*DDT		Metabolites of *p,p'*DDD (DDMU and others excreted or not measured) (ppm)	Accumulated total DDT (ppm)	Observed percent			Concentration based on observed percent		
				Accumulated *p,p'*DDE (ppm)	Accumulated *p,p'*DDD (ppm)			*p,p'*DDT (%)	*p,p'*DDE (%)	*p,p'*DDD (%)	*p,p'*DDT (ppm)	*p,p'*DDE (ppm)	*p,p'*DDD (ppm)
1949 (1)	0.37	0.37	0.31	0.03	0.02	0.01	0.06	74.4	23.3	2.3	0.27	0.08	0.01
1950 (2)	37	.74	.54	.10	.07	.03	.70	70.0	23.3	6.7	.49	.16	.05
1951 (3)	37	1.10	.69	.20	.12	.09	1.01	64.0	21.1	14.9	.65	.21	.15
1952 (4)	37	1.47	.81	.33	.16	.18	1.29	58.5	21.9	19.6	.76	.28	.25
1953 (5)	37	1.84	.88	.47	.20	.29	1.55	55.9	19.7	24.4	.87	.31	.38
1954 (6)	37	2.21	.94	.62	.22	.42	1.79	54.8	31.1	14.1	.98	.56	.25
1955 (7)	37	2.58	.98	.78	.24	.57	2.01	48.9	39.5	11.6	.98	.79	.23
1956 (8)	37	2.94	1.01	.95	.26	.73	2.22	48.7	37.0	14.3	1.08	.82	.32
1957 (9)	37	3.31	1.03	1.12	.27	.89	2.42	39.5	49.7	10.8	.88	1.20	.33
1958 (10)	37	3.68	1.04	1.29	.28	1.07	2.61	No data					
1959 (11)	37	4.05	1.05	1.47	.29	1.24	2.80	38.4	51.4	10.2	1.08	1.44	.29
1960 (12)	37	4.42	1.06	1.64	.29	1.42	2.99	47.9	45.1	7.2	1.43	1.35	.22
1961 (13)	37	4.78	1.06	1.82	.29	1.61	3.18	33.4	57.0	9.6	1.06	1.81	.31
1962 (14)	37	5.15	1.07	2.00	.30	1.79	3.36	26.9	62.8	10.3	.90	2.11	.35
1963 (15)	37	5.52	1.07	2.18	.30	1.97	3.55	32.0	61.3	6.7	1.13	2.17	.24
1964 (16)	37	5.89	1.07	2.36	.30	2.16	3.73	24.0	68.7	7.3	.89	2.56	.27
1965 (17)	37	6.26	1.07	2.54	.30	2.35	3.91	34.1	59.8	6.1	1.33	2.34	.24
1966 (18)	37	6.62	1.08	2.72	.30	2.53	4.09	12.9	79.5	7.6	.53	3.25	.31
1967 (19)	37	6.99	1.05	2.89	.30	2.72	4.27	No data					
1968 (20)	37	7.36	1.08	3.07	.30	2.91	4.45	No data					
1969 (21)	37	7.73	1.08	3.25	.30	3.10	4.63	No data					
1970 (22)	11	7.84	.65	3.41	.29	3.28	4.56	15.9	75.3	8.8	.72	3.43	.40
1971 (23)	60	7.81	.60	3.54	.25	3.45	4.39	No data					
1972 (24)	00	7.84	.43	3.62	.20	3.59	4.25	9.0	79.2	11.8	.38	3.37	.50
1973 (25)	00	7.84	.30	3.68	.15	3.70	4.14	No data					

in Santa Monica Bay in 1970, 8:87:6, and by a bottom sediment sample taken near the sewer outfall in 1971, 6:82:12. Samples of sewer water taken in 1970 that derived their DDT content from sewer sediments had ratios of 14:38:48 (Redner and Payne, 1971).

A few specimens of another myctophid, *Triphoturus mexicanus*, also showed a change in CHC ratios with time. Twenty-one specimens taken between 1950 and 1959 contained an average of 69% DDT, 9% DDD, and 22% DDE, while 12 specimens taken between 1961 and 1970 contained 23% DDT, 15% DDD, and 62% DDE. These fish were taken between Los Angeles and southern Baja California (lat 26°20'N). This species has a more southern distribution than *Stenobrachius leucopsarus*, and therefore the population was less influenced by the sewer discharge.

One might expect that DDE would be more abundant in samples taken farther from the sewer outfall, indicating older deposits, but this is not the case. The proportions are very similar in all samples, even those taken outside of the influence of the sewer. For the fish samples taken in 1969-70 for the survey, the percentages are given in Table 3.

Each sample contained several fish of the same species, and only the livers were tested. Where the pesticide levels were very high, the proportions were remarkably similar among samples. For the eight Santa Monica Bay samples, the DDE ranged from 85.2 to 87.7%, DDD from 5.1 to 6.6%, and DDT from 5.7 to 9.1%.

TABLE 3.—Distribution of *p,p'*DDE, *p,p'*DDD, and *p,p'*DDT in fish samples by area taken, 1969–70.

Location	Number of samples	Percent as DDE	DDD	DDT
Southern Baja California	8	80.6	8.9	10.5
Sebastian Vizcaino Bay	3	74.2	8.8	17.0
Cortez Bank	4	85.5	4.7	8.8
Southern California coast	6	85.0	5.1	8.9
Farnsworth Bank	6	86.9	5.6	7.5
Santa Monica Bay	8	86.6	5.8	7.6

The high proportions of DDE relative to DDT and DDD seem to be typical of fishes, porpoises, and crustaceans in the ocean off southern California (Tables 4 and 5). In six adult pelicans taken on Anacapa Island in 1969 (Keith et al., 1970), DDE made up 99% of the total DDT found in the fat, and 93% in eggs taken at the same time. Lamont, Bagley, and Reichel (1970) tested 10 pelican eggs from the same place and year and found that DDE constituted 96% of the total.

Stout (1968) gives data for 17 samples representing seven species of marine fishes taken off Washington and Oregon. In these, DDE averaged

TABLE 4.—Percent distribution of total DDT and ratio of DDD to DDT in rockfishes and sablefish from Santa Monica Bay. Major dumping of DDT wastes into sewer system stopped in April 1970. Samples of May 1970 and August 1971 are averages of five separate samples each for fat, liver, and flesh. In each of these 15 samples the ratio of DDE to DDT was greater than one.

Species	Part tested	Total DDT (ppm)	Percent distribution DDE	DDD	DDT	Ratio DDD:DDT
May 1970						
Sebastes paucispinis	Liver	519.0	86.3	5.6	8.1	0.69:1.00
S. paucispinis	Flesh	11.6	80.6	8.8	10.5	.82
S. miniatus	Liver	162.0	87.0	5.6	7.4	.75
S. miniatus	Flesh	16.0	92.3	trace	7.7	00
S. constellatus	Liver	1,005.0	87.7	5.5	6.8	.80
S. constellatus	Flesh	57.2	88.2	5.5	6.3	.86
S. constellatus	Fat	2,528.0	85.0	7.0	8.0	.87
Anoplopoma fimbria	Liver	103.0	87.3	5.8	6.9	.85
A. fimbria	Flesh	23.4	81.2	10.1	8.7	1.15
August 1971						
S. paucispinis and *S. mystinus*	Liver	156.0	84.0	10.3	5.7	1.78
A. fimbria	Liver	38.0	84.2	12.9	2.9	4.45
January 1972						
S. paucispinis	Liver	17.0	78.5	15.5	6.0	2.58
S. paucispinis	Flesh	2.0	81.4	12.7	5.9	2.15
S. paucispinis	Fat	119.0	78.8	16.1	5.1	3.15
August 1971						
Bottom sample	Mud		85.0	12.0	6.0	2.00

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TABLE 5.—Distribution of *p,p'*DDE, *p,p'*DDD and *p,p'*DDT in various animals from southern California marine waters. Porpoises found dead on beach north of San Diego, various dates May 1970. Fishes and crustaceans taken in net haul in San Pedro Channel 4 August 1971.

Species	Organ tested	Standard length (mm)	Wet weight (g)	Total DDT (ppm)	Percent as DDE	DDD	DDT
Porpoises:							
Lagenorhynchus obliquidens	flesh			84.	92.0	2.3	5.7
Delphinus sp.	flesh			208	85.5	5.8	7.7
Delphinus sp.	flesh			31.	85.0	7.2	7.8
Delphinus sp.	liver			44.	90.7	4.8	4.5
Delphinus sp.	liver			300	92.0	4.0	4.0
Delphinus sp.	head oil			156	89.5	2.6	7.6
Delphinus sp.	blubber			497.	88.5	3.4	8.1
Fishes							
Leuroglossus stilbius	whole	84	5.20	.49	75.9	11.6	12.4
Melanostigma pammelas, eelpout	whole	89	2.40	5.63	87.9	2.7	9.4
Argyrocoe ecus sp., hatchetfish	whole	30	.50	.03	49.5	7.6	42.9
Cyclothone acclinidens	whole	48	.36	2.01	80.7	4.7	14.6
Cyclothone acclinidens	whole	43	.37	.64	76.1	6.9	17.0
Cyclothone acclinidens	whole	47	.39	2.45	83.2	5.9	10.9
Cyclothone acclinidens	whole	38	.18	3.56	89.5	4.5	6.0
Cyclothone acclinidens	whole	34	.15	1.55	84.9	8.5	6.6
Cyclothone acclinidens	whole						
Crustaceans:							
Gnathophausia gigas, pelagic mysid	whole		.42	.55	76.7	7.2	16.1
Sergestes sp.	whole		.64	4.09	85.1	6.1	8.8
Sergestes sp.	whole		.39	4.59	82.9	6.1	11.0
Nematoscelis sp., euphausiid	whole		.019	25	90.3	4.3	5.4
Nematoscelis sp., euphausiid	whole		.043	26	90.2	3.0	4.9

52% (26–81), DDD 20%, and DDT 28% of total DDT.

Keith and Hunt (1966) list DDT content for samples of mammals, birds, and freshwater fishes taken throughout California. The proportion of DDE tends to be high in categories that include birds of prey and fish eating birds, but varies considerably in their other samples. In their warm-water fish samples and the fish eating birds, white pelican, western grebe, and common egret, DDD is unusually high. This may be because of the former use of DDD as a spray on some California lakes (Murphy and Chandler, 1948; Brydon, 1955; Hunt and Bischoff, 1960).

Following the cessation of DDT dumping into the ocean off Los Angeles [illegible] occurred in the DDD:DDT [illegible] samples. The five *S.* [illegible] contained 79% DDE, 12% DDD, and 9% DDT. Each of the five specimens contained more DDD than DDT. In the period 1963–70, only 8 out of more than 250 *S. leucopsarus* tested contained more DDD than DDT. The five myctophids taken in April 1972 ranged from 40 to 61 mm SL, indicating that most or all of their growth had taken place since dumping started in 1947.

The shift in DDD:DDT [illegible] some other species. The ratio [illegible] table 5 is *Anoplopoma fimbria* [illegible] Monica Bay in May 1970, indicated that DDT was more abundant than DDD while 15 and 20 mo later the reverse was true (Table 4, Figure 11). The pelagic crustaceans and fish taken in the midwater trawl in August 1971 (Table 5) did not show the increased DDD to DDT ratio as did the bottom fish taken at that time, or the five *S. leucopsarus* taken in April 1972. A mud sample taken in August 1971 (Table 4, Figure 12) about 3 nautical miles from the White Point sewer outfall contained about twice as much DDD as DDT.

The work of Burnett (1971) on DDT residues in the sand crab along coastal California showed that the high ratios of DDD to DDT were a local condition. Twelve samples taken in November 1970 and February 1971 from [illegible] on either side of the White Point sewer outfall between 34°22 N and 34°28 N contained more DDD than DDT in all but two samples. The 11 stations north and south of this area all contained less DDD than DDT. The four samples taken closest to the outfall averaged more than three times as much DDD as DDT.

This shift in DDD:DDT ratios was undoubtedly caused by the deposits in the sewer system. CSDLAC cleaning operations started in December 1970 and [illegible] in July 1971. Although large [illegible] of DDT [illegible] were removed from the [illegible]

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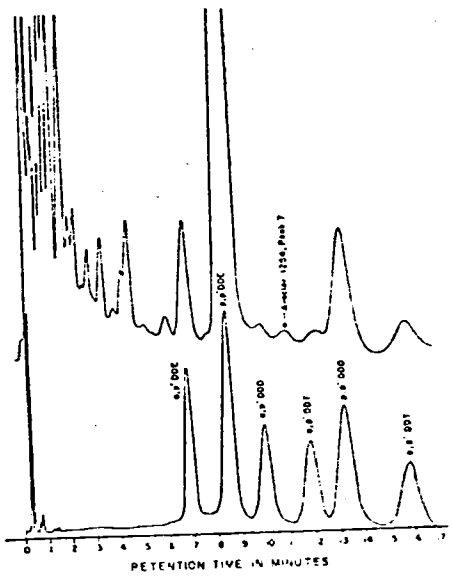

FIGURE 11.—Chromatogram of DDT analog standard and of a fat sample from *Sebastes paucispinis* taken in Santa Monica Bay 7 January 1972. *p,p'* DDE (98 ppm) is off scale. Following cessation of dumping of DDT wastes and flushing out of sewer lines in 1970, *p,p'*DDD (15 ppm) has exceeded *p,p'*DDT (5.1 ppm) in most fish specimens tested. Prior to cessation of dumping and flushing of sewer lines, DDT was almost always present in greater quantities than DDD.

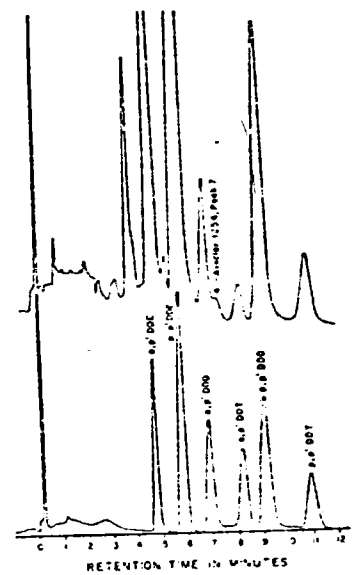

FIGURE 12.—Chromatogram of DDT analog standard and sample of mud from the ocean floor in the Los Angeles area taken in August 1971, 16 mo after most dumping of DDT wastes stopped. DDD greatly exceeds DDT. This may have resulted from the sewer cleaning operations, or it may have been the condition existing before and merely reflect what the biota can excrete more easily. In the *Sebastes* chromatogram (Figure 11), the *o,p'* DDE peak is within the limits of the tight proportions to *p,p'* DDE for it to be considered *o,p'* DDE. In the mud sample it is much too high and may be DDMU (a metabolite of DDD) which has the same retention time on this column as *o,p'* DDE.

Point plant and out into the ocean. Sewer water from these deposits contained 48% DDD as opposed to 2–6% in the original Montrose discharges, and although the total amount of DDT and its metabolites was much less than before April 1970, the total amount of DDD entering the ocean appeared to be several times greater than it had been before the dumping stopped in April. This would account for the increase in DDD in the myctophids taken in 1972 rather than the expected decrease indicated by the calculated line (Figure 10, Table 1). A mud sample taken from the ocean floor a few miles from the sewer outfall in July 1971, just after the sewer cleaning operations ceased contained 6% DDT, 82% DDE, and 12% DDD (Figure 12). This compares favorably with the myctophids taken in April 1972, 9:79:12, and the *S. paucispinis* fat samples (Figure 11) taken in January 1972, 5:79:16, and indicates that the fish reflect the values of these analogs in the environment fairly well.

The most noticeable difference between the pesticide metabolites in the fish (Figure 11) and the mud (Figure 12) were the two prominent peaks preceding *p,p'*DDE. The peak at the locus of *o,p'*DDE also may contain DDMU, a metabolite of DDD. The other peak could be a metabolite of Kelthane. However, several dozen additional mud samples tested subsequently did not contain these peaks except for expected amounts of *o,p'* DDE. The mud sample (Figure 12) was run while we were experimenting with methods of determining pesticide content of the mud samples. The subsequent samples were run after we had settled on a different method that gave maximum recovery of DDT, DDD, and DDE without special regard to other CHC. These subsequent mud samples yielded chromatograms almost identical with those of fish and other biological samples from the same general area.

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There was also a large decrease between May 1970 and January 1972, in total pesticides in the fish taken in Santa Monica Bay (Table 4). The *S. paucispinis* taken in 1972 were smaller than those taken in 1970 which may account in part for the lower values. The five specimens taken in January 1972, averaged 312 mm total length. Phillips (1964) gives the total length of this species at age 2 as 267 mm and at age 3 as 343 mm. Thus, most of the growth of these specimens had taken place since dumping stopped.

On land where soil has been subjected to DDT spraying for long periods of time, the situation is very different. In New York State vineyard soils (Kuhr, Davis and Taschenberg, 1972) the residues consisted of 73% DDT and 27% DDE after 24 yr of spraying with DDT. In Oregon (Kiigemagi and Terriere, 1972) samples of soil from one orchard contained 80% DDT, 17% DDE, and 3% DDD after 25 yr of spraying, while soil samples from another orchard in a different area contained 75% DDT, 14% DDE, and 8% DDD after 24 yr. Forests in New Brunswick, Canada (Yule, 1973) were sprayed heavily from 1956 to 1967 in which year spraying with DDT ceased. Many samples taken of soils in this area in 1968 contained 92% DDT and 8% DDE. Three years later a second sampling of the soils in the same locality contained 90% DDT and 10% DDE. DDD was present only in trace amounts in both sampling years.

As a general rule soil samples from land areas that have been sprayed with DDT tend to contain a much higher proportion of DDT than DDE or DDD even after many years. This is not necessarily true of the fauna that inhabit the land unless their contamination is the result of recent spraying. Keith and Hunt (1966) give examples of a number of species of mammals and birds in which the proportions of the three analogs vary greatly.

Within some species of birds, which are more wide ranging than mammals, there seems to be remarkable uniformity in the proportions of the three analogs. Martin and Nickerson (1972) tested 125 10-bird samples of starlings from throughout the (48) United States. These samples averaged 91% DDE, 3% DDD, and 6% DDT. Although the total residues ranged from 0.05 to 15 ppm, in only two samples did the amount of DDD exceed DDT, and in only one did the amount of DDT exceed DDE.

The proportions of the three analogs of DDT in the starlings is very similar to the proportions found in the fish taken in Santa Monica Bay in 1970 (Table 4), in the porpoises found dead on the beach in 1970, and the small fishes and invertebrates taken off Los Angeles in the mid-water trawl in 1971 (Table 5). And, in fact, except in cases of recent contamination by DDT, most fauna have tended to approach these proportions in recent years. This is in spite of the fact that soil samples from areas of land that have long histories of spraying with DDT almost without exception contain very high proportions of DDT. From this it would appear that the selective storage, metabolism, and excretion of DDT is somewhat similar for all animals.

When investigators first became aware of the pesticide problem, methods of measuring residues were considerably less refined than they are at present, and few samples were run. Very little work has been done on preserved specimens from these earlier years. But, in view of the similarity in proportions of DDE and DDT in so many different species in recent years, it seems probable that the increase in DDE and the change in ratios of DDE and DDT in *S. leucopsarus* are descriptive of the general change in these analogs that has taken place in the earth's environment.

There was no pattern discernible in the distribution of Aroclor 1254. In 472 myctophid samples taken between 1949 and 1966, the median values of Aroclor 1254 fluctuated around 0.17 ppm and showed no trend with time. Sixty-eight percent of the samples contained less than 0.25 ppm. The only indication of an areal relationship was that while the three stations closest to the White Point sewer outfall, and the city of Los Angeles (CalCOFI stations 57.35, 90.28, and 90.30) constituted only 8% of the total samples, they accounted for 34% (12 out of 35) of the myctophids containing more than 1ppm of Aroclor 1254. However, there were some samples taken 175-220 nautical miles offshore that contained more than 1 ppm, and there were others taken near shore in the Los Angeles area that contained none or traces only. These higher values could result from the myctophids ingesting nondigestible particles of man-made substances either while feeding or accidentally while in the cod end of the plankton net.

In the larger fish taken in the Los Angeles area, the high values of the DDT analogs tend to mask the presence of Aroclor 1254. What is [illegible] recorded as a trace amount could actually be a rather significant amount in view of the other

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solutions of sample used in such cases in order to keep the DDT residue recordings on scale.

SUMMARY

1. Between 1949 and 1970, total DDT increased in the ocean off southern California. The major source of this insecticide apparently was wastes discharged into the Los Angeles County sewer system by a major manufacturer of DDT.

2. As measured in the myctophid fish, *Stenobrachius leucopsarus*, *p,p'*DDT and *p,p'*DDD increased for several years until metabolism, excretion, and dispersion equalled input, at which point the content of these CHC stabilized in the fish.

3. The more persistent, less easily metabolized *p,p'*DDE continued to increase in *S. leucopsarus* throughout the time period under study. The amount of *p,p'*DDE decreased with distance from the sewer outfall.

4. During the earlier years the abundance of the other analogs [illegible] *p,p'*DDE, and *p,p'*DDD [illegible] period through 1970 [illegible] became more abundant [illegible] ing cessation of dump[illegible] more abundant than *p,p'* DDT in the myctophids and most of the other fish species tested.

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